POWER

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Power at Less Than Cost

THERE seemed to be hopeful signs that the recognition by some of the wiser, broadminded and far-seeing managers of public utilities of the fact that some industrial plants can make power more cheaply than it can in justice be sold to them, was gaining ground.

It is therefore with disappointment that we read the following frank expressions of an opposite extremist:

> The central station should supply *all* the electrical energy requirements of its community. So long as any local industry is obliged to supply its own electric power the local central station has failed in its full duty.
>
> It should supply all these electrical loads at a profit, but that profit need not be a constant percentage.

In other words, it should be based on what the traffic will bear.

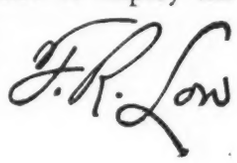
If a prospect is so favorably situated that he can produce his power at less than the rates charged to others the rate to him should be cut until he is forced to buy. The central station must make *all* the power.

But everybody qualified to discuss the question knows that a plant that uses steam for heating and process work can make, within the limits of that use, power cheaper than it can be made and delivered at a profit by any central station.

And they know that power cannot be sold at a profit at prices less than those for which many industrial plants can produce it, when the central station cost is computed on the basis upon which costs are certified to the public service commissions.

As spokesman for the users of power, far be it from us to complain of any proposal to furnish it cheaply, even though as customers of the utilities we are all assessed to make up the shortage.

But it is not sound economics, and it will benefit the fortunately situated industry only so long as it maintains and is able and inclined to employ the advantage that compels the original discrimination in its favor.



POWER *Stands for . . .*

1. **Making Power When It Should Be Made**
2. **Buying Power When It Should Be Bought**
3. **Cheaper Power Through Modern Equipment**
4. **Easier Financing of Equipment Purchases**
5. **Better Use of Byproduct Heat and Power**
6. **Operating Methods That Save Money**
7. **Less Waste in Transmission and Application**

Welding Progress Is Backed by Research

SCIENTIFIC research will do more for an industry in ten years than rule of thumb can accomplish in as many centuries. That is why some of the new synthetic chemical industries, such as pyroxylin lacquers and artificial leather, are running rings around their older brothers. And it tells why welding applications are advancing at a breath-taking pace.

The welding industry has been wonderfully fortunate, particularly in the last five years, in its whole-hearted acceptance of scientific research. Manufacturers, large users and scientists in governmental institutions and universities are constantly studying the welding process. Constant interchange of information between "field" and laboratory keeps each group intimately in touch with what the other is doing.

The result of this union of pure and applied science is just what might be expected—sound expansion of the welding process at an unprecedented rate, with rapidly growing income for the manufacturers of welding equipment and supplies and even greater savings by the user of welding in industry.

Replacement of castings by welding is growing at a rapid rate. In three or four years structural welding has gained recognition as a commercial process. Pipeline welding at the rate of millions of dollars monthly is in progress. In this field other methods of fabrication are now practically obsolete.

It is hard to find a new installation of industrial piping and pressure vessels, for steam, air, water, ammonia or brine that does not contain a substantial amount of welding, and the volume of such welding is rapidly increasing. The chemical industries have seized upon the the process as a life saver in the fabrication of apparatus to handle valuable or noxious fluids.

In all of these applications progress has been continuous and sure only because application has been supported by the steady arm of research.

The fact that reseach, in turn, has the ardent moral and financial backing of the whole welding industry is the best security for a continuation of that progress.

Generating Power at the Mine Mouth

EVERY so often the question of the mine-mouth power plant is brought forward in the press and proposed installations are made the subject of considerable discussion. Most of this comment tends to be violently pro or con. Some can see no justification for such a development, holding that such factors as the cost of the transmission of the current generated and the difficulty of obtaining good feed water and abundant condensing water more than offset the saving on coal haulage. Others, taking perhaps a broader view, see only the advantage that will come from relieving the railroads of a vast tonnage of coal, and so favor the scheme regardless of its economy as a power source. Still others maintain that the water and transmission problems can be met when need arises and that the lower fuel cost at the mine warrants the development.

Certain existing plants that can be considered as mine mouth, due to their location in close proximity to a coal field, tend to encourage the "pro" side of this argument. But, in reality, other factors determined the selection of these sites. Sizable rivers as water sources and a nearby market for the current will be found to exist, either singly or together, in all these cases. So the true mine-mouth plant about which so much is heard remains to be built.

Of course, changes in practice have made such a plant more feasible than it was in the past. Higher pressures require less water per unit of output than was formerly needed. Higher transmission voltages and improved equipment have cut the losses that are involved in distributing the current to points far from its source. But, in spite of these advances, the present type of power station still does not seem to attract sufficient support as a mine-mouth installation to result in any actual construction.

There is, however, another type of plant, just appearing over the horizon, as it were, that may put a different face on this mine-mouth power problem. This is a threefold development, the primary object of which is the treatment of coal, resulting in smokeless fuel, gas and tar-oils as first products. Such a plant, with a power station and a chemical factory for working up the by-products, can achieve a nearly perfect heat balance without the use of any great quantities of water. Using low-priced fuels, such as coke breeze and scrubbed gas, the power-generating cost should be small enough to allow more margin for transmission-line costs.

In *Power* for April 23, 1929, W. R. Knapp and Paul McMichael showed how a combination of low-temperature carbonization plant and power station would give power cheaper than is at present obtained with coal costing $2.65 per ton. With cheaper fuels, the results should be even more advantageous. Those interested in the mine-mouth power plant would do well to watch such developments as forecast by the low-temperature plants at New Brunswick, Chicago, and Windsor.

Line-Start Motors Create New Application Problems

CHANGES in the design of squirrel-cage induction motors have made obsolete the rules for selecting belts and some other types of mechanical power-transmission equipment. With direct-current motors the control is so designed that the motor develops a starting torque to suit the load requirements. This also is true of wound-rotor induction motors and is approximated with squirrel-cage motors started with compensators. When compensators are used motors are usually started on one point of reduced voltage and then connected to full voltage. Although this is not the ideal method of bringing a motor up to speed the compensator has been fairly satisfactory.

Many motor manufacturers are now supplying what are known as line-start squirrel-cage motors. These motors are started by connecting them directly across the line. Consequently they develop maximum torque at starting. Power-transmission equipment that might prove adequate when starting under reduced torque may not be adequate when used where the maximum torque of the motor is suddenly applied. Belts that were satisfactory for motors that were accelerated on reduced voltage are proving unsuited to motors that are put into operation by connecting them directly to the line.

This is an example of not giving proper consideration to the motor and the power-transmission equipment as a unit. The starting characteristics of the motor were radically changed, but the effects this might have on the power-transmitting equipment and the driven machine were, in general, neglected. It is now recommended by power-transmission authorities that the belts for normal-torque line-start motors be twenty-five per cent wider and for high-torque motors of the same type, fifty per cent wider than those used with motors brought up to nearly full speed on reduced voltage before applying full line potential.

When Experts Disagree

THERE have been boiler explosions since steam began to serve man for the production of mechanical power; and there probably always will be. However, it is gratifying that the last twenty-five years have seen a steady decrease in the number of disastrous failures, due, no doubt, to better materials, adherence to codes and more intelligent supervision. This is in spite of the harder service imposed by modern operating practice, which often introduces factors that complicate the problem when failures do occur.

In the case of the Crossett boiler, which exploded with disastrous results, as reported in the July 2 number of *Power* and discussed elsewhere in this number, caustic embrittlement was suspected, in view of the feed water treatment used and the low sulphate content of the raw water. F. G. Straub, whose researches along this line have rendered him an authority on caustic embrittlement, reports indisputable evidence of this in the intercrystalline cracks found in samples cut from the section that failed.

On the other hand, the Detroit Testing Laboratory, after an examination of such samples, reports the cracks are of a transcrystalline nature, rather than intercrystalline, and finds no evidence of caustic embrittlement. The chemical and physical properties of the plate were found to be good.

In the statement issued by the Sessions Engineering Company, consulting engineers, who originally installed the plant, it is contended that "the concentration of the boiler water was taken consistently and periodically and during the three years preceding the failure the total alkalinity in samples from the boiler varied from 35 to 45 grains per gallon."

The crux of the situation was believed to lie in the fact that both the inside and the outside of the seams were calked, which precluded evidence of the existing localized condition through leakage to the outside. This is a point that would bear further investigation with a view to establishing a standard practice.

Thomas Newcomen, Practical Engineer

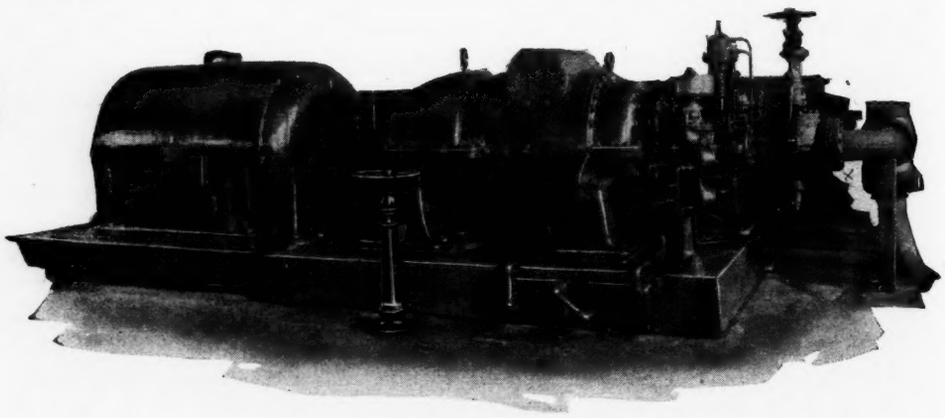
SO MANY tales of "tremendous progress" have lately been compiled, so many anniversaries of early workers have been celebrated, so many names have been dragged out of obscurity for a brief day, or week, of speech-making, medal-casting, that such remembrances are apt to grow a little trite.

Thomas Newcomen, who died two hundred years ago on August 5, needs no belated publicity to insure his fame. The inventor of "The Engine for Raising Water with Power Made by Fire"—the first successful atmospheric steam engine—has all modern industry for a monument. As we look at Newcomen's work, back over two centuries of progress to his first crude pumping engine in an English mine, it will not be for Newcomen's sake, but for our own, that we glance at history for a moment.

In 1698, Thomas Savery patented a fire engine. During the next few years he exhibited models and published a book berating the industrial world of his time for not adopting it. Savery's engine would have worked—if it could have been built, but his design demanded better workmanship than was available at the time, and his efforts went for naught.

In 1712, under the patent of Savery, Newcomen built a successful engine. He was able to start civilization on a new and ever-widening road, because he made a design that the machinist of his day could build sucessfully—a crude design, but one that performed its appointed task. Newcomen's engine has long been obsolete, but that ideal of practicability which made Newcomen successful where Savery had failed is still the cornerstone of engineering achievement.

Glenlyon Print Works Lowers Costs by PLANNED POWER DEVELOPMENT



New 1,000-kw. generating unit

By S. W. Allen and F. J. Fales
Plant Engineer *Cost Accountant*
Sayles Finishing Plants, Plant C.

***MODERN BOILER EQUIPMENT** in the Glenlyon Print Works, Phillipsdale, R. I., cut seven cents from the cost of steam per thousand pounds (incuding overhead). Change from powdered coal to low-priced oil saved another two cents. At the same time the total steam consumption per unit of product has been cut down by the more complete recovery of by-product power.*

THE Glenlyon Print Works is one of five modern plants owned by the Sayles Finishing Plants, Inc., four of which are located in Rhode Island and the fifth in North Carolina. It is situated in Phillipsdale, R. I., across the Seekonk River from the city of Providence. Cotton, silk and cotton, and real and artificial silk, are bleached, dyed, and printed.

Realizing the importance of economical generation of steam and electric power, the Glenlyon Print Works started, a few years ago, a modernization program for its power plant. This program has practically been brought to completion, and the results obtained to date have proved the wisdom of the plan.

From its location at tide water on the Seekonk River with connections over the New York, New Haven & Hartford Railroad, two methods of receiving fuel are at hand, both coal and oil being available in large quantities and at reasonable rates.

As originally installed, the boiler house contained seven hand-fired boilers and two stoker-fired boilers, one of 5,000 sq.ft. and the other of 6,000 sq.ft. Oil firing was later substituted for coal, the price of oil at the time being such that large economies were effected.

The seven smaller boilers were nearing the end of their usefulness, and when it became apparent that the boiler house of the adjoining Glenlyon Yarn Dye Works would have to be discontinued or rebuilt, it was decided to build a modern boiler house at the print works to handle the steam demands of both plants.

Before modernization was started, the turbine room consisted of one 600-kw. condensing turbine unit, one 500-kw. non-condensing turbine-generator unit and a 100-kw. engine-driven generator. There were also two motor-generator sets and two balancer sets to take care of the direct-current load. The condensing unit was remodeled to operate non-condensing in view of the heat-balance conditions at this plant.

During the installation of three new 8,000-sq.ft. boilers the load was carried on the seven hand-fired boilers and on the 5,000- and 6,000-sq.ft. units.

Three methods of firing the new boilers were considered: oil, stokers and pulverized fuel. The idea of oil was discarded, for the time being, due to uncertain price conditions. With a fluctuating load demanding great flexibility and with long periods of light loads when the banking losses with stokers would be high, the conditions seemed favorable for a pulverized coal installation. Moreover the closer air regulation possible with pulverized fuel would reduce the quantity of flue gas so that the old stack could be utilized, whereas a new one would have been necessary with stokers.

It was therefore decided to install a pulverized-fuel system in conjunction with oil-burning equipment. The oil burners were of advantage through the construction period, during which time it was necessary to maintain steam for plant use. Oil being in use in the old plant, little expense was necessary for equipping the new one to burn it.

The three 8,000-sq.ft. boilers were installed on one side of the firing isle, with a full basement underneath.

Unit pulverizers were purchased and placed in a separate room in the basement, coal being fired through three 12-in. burners in each boiler. The pulverizers are controlled from panels on the firing floor, one for each boiler. The boilers are equipped with feed-water regulators, superheaters, soot blowers and a vacuum system for removing soot from the last pass.

Provision was made in the boiler design for continuous operation at 175 per cent of rating. The walls are of solid fire brick, laid up in fire clay. The ash hopper is of hollow-wall design, with air for combustion drawn through the ducts and preheated, part passing through the pulverizer and the remainder through the air side of the fan. Four oil burners are installed below the three coal burners.

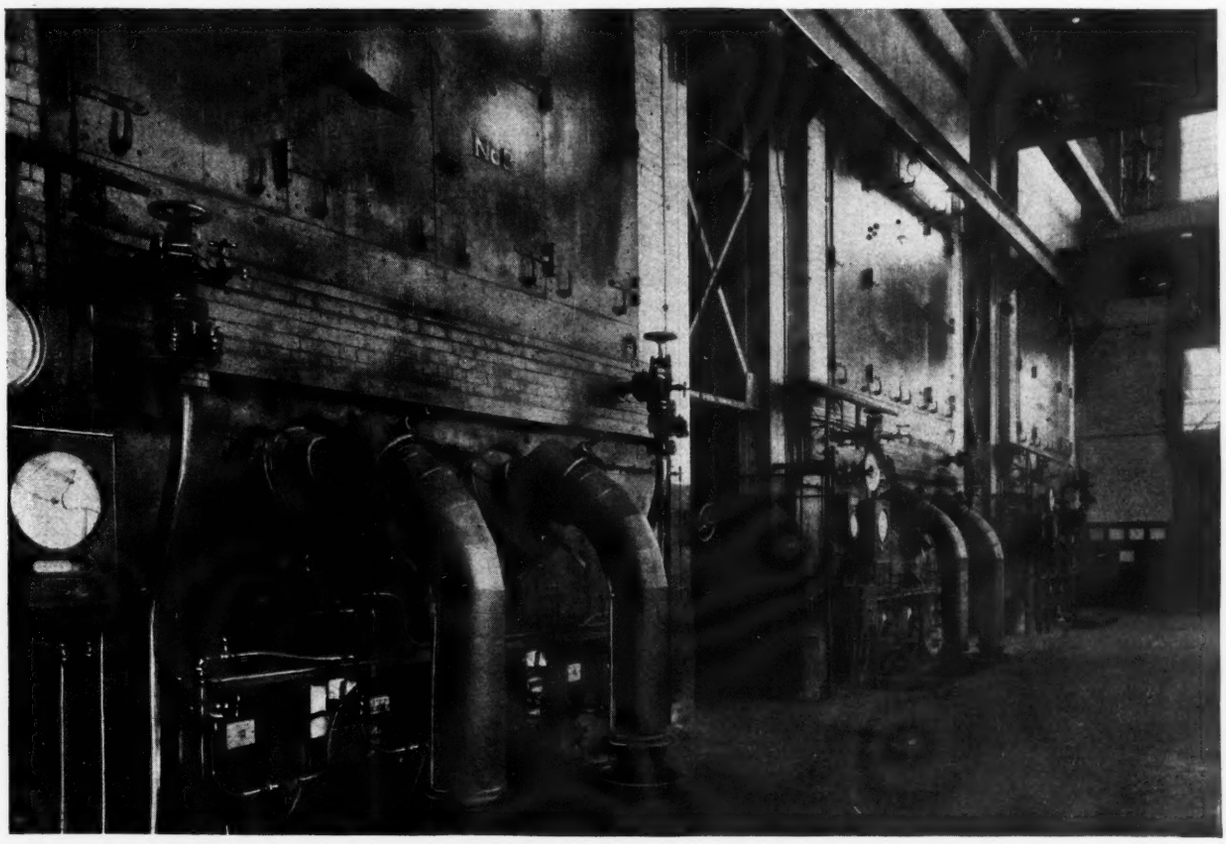
Coal is reclaimed from the storage yard and deposited in a hopper by a locomotive crane. From there it feeds by gravity to the crusher, outside the boiler house. The crushed coal is passed over a magnetic pulley and is raised by a bucket elevator to a conical bin on the boiler house roof.

The pulverizers take their coal from a weigh larry, records being kept of the coal fed to each boiler. Individual hoppers of eight-ton capacity, on the firing floor, feed coal by gravity to the mills in the basement floor. Provision is made for inspection to note if the coal is feeding properly, the hopper being so designed that the coal can be forced from the firing floor in case of arching. Each pulverizer is equipped with a magnetic separator.

Hollow-tile construction is used for the furnace hopper-bottoms. Air is admitted at the bottom, passes up through the sloping walls, and is then conducted through ducts to the pulverizers. A portion of the heated air is admitted to the inlet end of the pulverizers, passing through with the coal, the remainder being bypassed around the mills and admitted to the air side of the fans.

The pulverized coal and air from the mills are mixed with the bypassed air at the fan discharges. From that point they are conducted through large ducts of square cross-section, which divide into three smaller circular ducts. These carry the now thoroughly mixed coal and air directly to the burners. The remaining air necessary for combustion is admitted around the burners by means of adjustable louvres.

Starting and stopping buttons and the rheostat for controlling the speed of the feeder motor are located on the firing floor. The equipment for each boiler is mounted on a panel, together with the boiler instruments, which include a steam pressure gage, a CO_2 recorder and a boiler meter which records the air flow and rating, the flue gas temperature and draft, and integrates the steam flow from the boiler. The damper-operating mechanism is located at a point convenient to this panel.



New section of the boiler room, showing the 8,000-sq.ft. boilers

An open feed-water heater and two 400 gal.-per-min. turbine-driven centrifugal feed pumps were installed at the same time as the new boilers.

Since the new plant has been in operation it has been found that two ten-inch coal burners per boiler are better adapted to plant conditions than the three twelve-inch burners originally installed. This change has been made on two boilers, the third boiler being equipped with two of the original twelve-inch burners.

There are four hand-operated rotary ash gates in each hopper bottom, two on each side. Dump cars are pushed under these gates, and such ash as does not flow by gravity is hoed into them. Two soot hoppers are located in the basement, one over each track. The ashes

and soot are handled in the same cars. The cars are run out over an old ash track to the river bank, where the ashes are used as fill.

The boilers are normally operated at 175 per cent of rating, about 14.5 per cent of CO_2, and a draft of about 0.06 in. The flue temperature under these conditions runs approximately 465 deg. F. A steam pressure of 175 lb. and a superheat of 140 deg. are carried at present, it being intended to increase the pressure in the future. Various screenings of coal samples from the mills show a very uniform pulverization, about 95 per cent passing through a 100-mesh screen and 80 per cent through 200-mesh.

About a year ago oil prices reached such a level that it was found economical to shift from coal to oil. The resultant saving has shown the wisdom of originally equipping this plant to burn either fuel.

Accurate records are kept of the cost of coal and ash handling, operating labor, power consumed, boiler-feed water, steam and water for soot blowers and blowdown, and repairs and replacements. In this way a cost per thousand pounds of steam is arrived at and compared with previous average costs. It was found, after the plant had been in operation for a considerable period on coal, that a saving of seven cents per thousand pounds of steam over previous costs was being obtained. This saving takes into consideration the increased fixed charges on the new plant. Since the shift back to oil burning a further saving of two cents per thousand pounds has been noted.

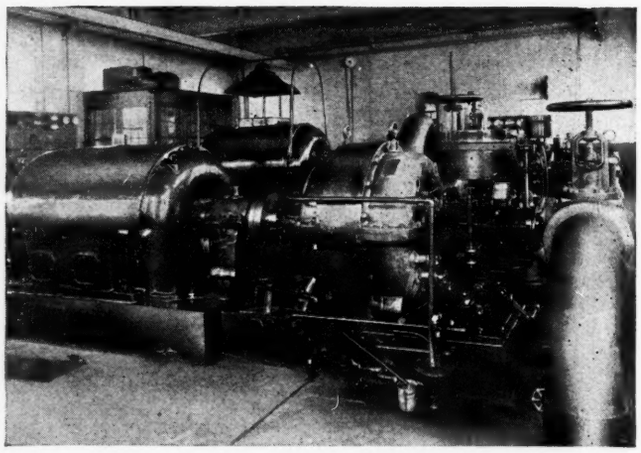
PRINCIPAL NEW POWER EQUIPMENT

Boilers, cross drum, water tube, 8050 sq.ft. of heating surface	Babcock & Wilcox
Superheaters, Foster	Foster Wheeler Corp.
Pulverizers, impact type, unit system, integral fans —8,000 lb. per hr. capacity— Simplex	Combustion Engineering Corp.
Magnetic separators, rotary type	Dings Magnetic Separator Co.
Burners	Combustion Engineering Corp.
Oil Burners,	The Engineer Co.
Coal Crusher, double roll	Stephens Adamson Mfg. Co.
Belt Conveyor,	Magnetic Mfg. Co.
Magnetic Pulley,	Magnetic Mfg. Co.
Bucket Elevator	Link-Belt Co.
Weigh Larry, 2 tons capacity—100 ft. per min.	Underwood Machinery Co.
Soot Removal System,	Girtanner Engineering Corp.
Soot Blowers,	Vulcan Soot Cleaner Co.
Boiler Meters,	Bailey Meter Co.
Draft Gages,	Bailey Meter Co.
CO_2 Recorders,	Brown Instrument Co.
Feed Water Heater, open	The Cochrane Corp.
Boiler Feed Pumps, 2,400 gal. per min., centrifugal	Goulds Mfg. Co.
Turbines, one, 1,000 kw.; one, 500 kw.	Moore
Turbines, one 500 kw.	Allis-Chalmers
Generators, one, 1,000 kw.; one, 500 kw.	Allis-Chalmers
Motor generators, one, 300 kw.,	Elliott Company
Motor generators, one 250 kw.,	Allis-Chalmers
Balancer sets, one, 50 kw.; one, 35 kw.,	Crocker-Wheeler
Exciters, one, motor driven,	Crocker-Wheeler
Exciters, one, Bullock engine driven,	Westinghouse

Because of increased plant loads, a power demand for driving pulverizers and an increased load at the water filter house, it became apparent that a larger electric-generating capacity was demanded. It was then decided that two new turbine units should be installed, one of 500-kw. and the other of 1,000-kw. capacity, at the same time eliminating the 100-kw. engine-driven set.

The first unit to be installed under this program was the 500-kw. machine, which replaced the engine-driven set. Because of the large demand for low-pressure process steam, it was decided to purchase a non-condensing turbine-driven unit, exhausting against eight pounds back pressure. The turbine is of the impulse type, having three stages. Steam is admitted to the nozzle ring by hand-operated valves, which insures economical operation at low ratings, the only period at which economy is desired.

The second unit in this program is the 1,000-kw. machine which has recently been put on the line. This turbine is five stage and of the same general characteristics as the unit mentioned above, with the exception that provision is made for future bleeding. The bleeder diaphragm is behind the Curtis stage which means economy at all bleeding conditions. The steam will be bled at 100 lb. pressure, which is suitable for plant process work. This provision for bleeding will take care of any future change in heat balance, when steam might otherwise be exhausted to atmosphere.



500 kw. turbine generator, with old machine in background

All three generators are of the same make and characteristics. Repair and replacement parts are thereby kept at a minimum because of interchangeability. The two newer generators are equipped with cell-type air cleaners to insure against the admission of foreign matter to the generator windings.

Excitation current is furnished by two separately driven exciters, one being engine driven and the other motor driven.

The direct-current load is handled by two motor-generator sets, one of 250-kw. capacity and the other of 300-kw. There are two balancer sets, one of 35-kw. and the other of 50-kw. capacity. A third, smaller, balancer has become obsolete and is to be removed. These balancer sets supply current for a multi-voltage system for operating variable-speed direct-current motors.

The cost department of the company reports a considerable net saving since the plant has been modernized.

Index of Volume 69

Readers who file or clip their copies of *Power* have use for an index; others do not. For this reason it has been the practice to supply the semi-annual index only upon request. A mailing list is maintained of those readers who have signified their desire to receive the index regularly. If you have not done so and want the index for the first six months of 1929 it would be well to send your request immediately to the Circulation Department.

Good Maintenance Practice Avoids Lost Time and Other Wastes

Freedom from shutdowns and serious accidents is a prime requirement of the efficient operation of a power plant, which largely depends upon how the maintenance man does his job. This article gives an outline for the work of this position which will serve as a standard for most plants to adopt.

By Walter N. Polakov*
Consulting Engineer, New York City

A STITCH in time saves nine. In power plant work it means much more. Timely attention prevents serious disasters, loss of life and limb. It also prevents idleness of men and equipment, not only in the power house but everywhere throughout the mill or factory.

To assign, from time to time, a mechanic trained in other classes of work to power plant repairs is bad practice. The power plant maintenance man must understand and watch continually the behavior of each part of power equipment, besides being a good mechanic.

It is penny-wise and pound-foolish to wait until "something happens" or efficiency begins to go down. Losses in fuel alone will accumulate ten times faster than the maintenance man's wages.

Duties of the Power Plant Maintenance Man

The maintenance man's duties consist of:

1. Periodical inspection of plant structure and equipment.
2. Keeping property, equipment, machinery and instruments at all times in first-class operating condition.
3. Repairing or supervising repairs done in the power plant.
4. Ordering all maintenance and repair materials, tools and supplies through the chief operating engineer.
5. Requisitioning such outside help as needed through the chief operating engineer.
6. Reporting progress of work, time taken, and expenses incurred to the chief operating engineer and the power clerk.

Responsibility: He is responsible to the chief operating engineer for:

1. Having all repairs done on schedule.
2. Keeping machinery in readiness for operation.
3. Maintaining equipment in such condition as to permit obtaining best efficiency.
4. Accuracy of all indicating and recording instruments (unless this is delegated to the power plant record man).

Authority: He has the authority to issue instructions:

1. To boiler repair men.
2. To all members of the repair gang.
3. To all mechanics temporarily assigned to work in the power plant.
4. To all persons engaged in repair or maintenance work when it is done by outside contractors.
5. To operating force regarding units out for repairs which shall not be put into operation.
6. To place and display safety signs.

Condition of Work: He reports to work daily at —— a.m. and quits at —— p.m. If overtime is required, same must be approved by the chief operating engineer except in emergency. He may be called at night in case of emergency. He is paid by the hour, with time and a half for overtime and double if called in at night.

Task and Bonus: The task of the maintenance foreman consists of maintaining all plant equipment in the highest state of repair at all times, insuring operation without interruptions and permitting earning of bonus on bonus jobs.

He receives as bonus ——— per day for any working day when no interference with operation occurred or no operating employee lost his bonus because of poor condition of machinery.

The maintenance man loses his bonus if any bonus was "allowed" to operating employee because of poor condition of equipment.

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POWER-FACTOR CORRECTION Reduces Cost of Electricity in Buildings

By J. F. LAMB
General Engineer
Westinghouse Electric & Manufacturing Company

IN PUBLIC BUILDINGS USING ALTERNATING CURRENT *the character of the load is such as to cause a low power factor. An engineering analysis and cost comparison are made of the different ways the power factor of these loads may be corrected. The conclusion is drawn that in most cases capacitors designed for the circuit voltage are the most economical.*

IN large public buildings the electrical equipment includes not only incandescent lamps but also a number of motors driving pumps, fans, elevator equipment, and other loads. The magnetizing kilovolt-amperes required by the induction motors will lower the building power factor. Neon lamps and transformers, although they take a small value of reactive kilovolt-amperes, may have an appreciable effect upon the building power factor, especially if the power company meters the reactive kilovolt-ampere-hours, because they are connected to the line a considerable portion of the day.

Many power companies have power-factor clauses in their rate contracts, or else base their billing upon kilovolt-ampere demand, which, in turn, depends upon the power factor of the building. A careful analysis will often show that for buildings purchasing alternating-current power from a local power company substantial savings can be made by improving the power factor of the building's load. The greatest saving will be found in cases where the power is metered on the high-voltage side of the distribution transformers and where 2,300-volt or 4,000-volt power-factor corrective equipment can be installed.

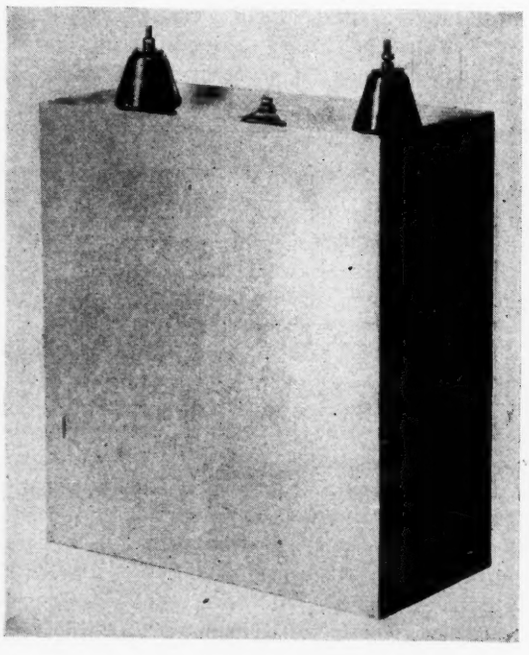
The power factor of the building can be improved either by changing the motor drives or by the installation of power-factor corrective equipment. Assuming that the motors in the building are properly selected as to horsepower, speeds, and starting requirements, it will usually be found best to install power-factor corrective equipment rather than to use some type of high-power-factor motors. Many of the motors in a public building are controlled by float switches and operate intermittently or drive fans which require some adjustment in speed and therefore cannot be very well replaced by synchronous machines. In most of the other motor applications in buildings it will be found that for the horsepower sizes required and considering the cost of the high-power-factor motors in comparison with the cost of power-factor corrective equipment it will be better to use the latter.

In the case of a building, such as a theater, with a large amount of air-conditioning equipment, it is often desirable to drive the compressors by synchronous motors. This will, of course, assist in improving the building power factor, but such equipment often is used only a portion of the year or of the day. Therefore, the synchronous motors are not quite as effective as capacitors for power-factor correction, since the latter can be left on the line at all times.

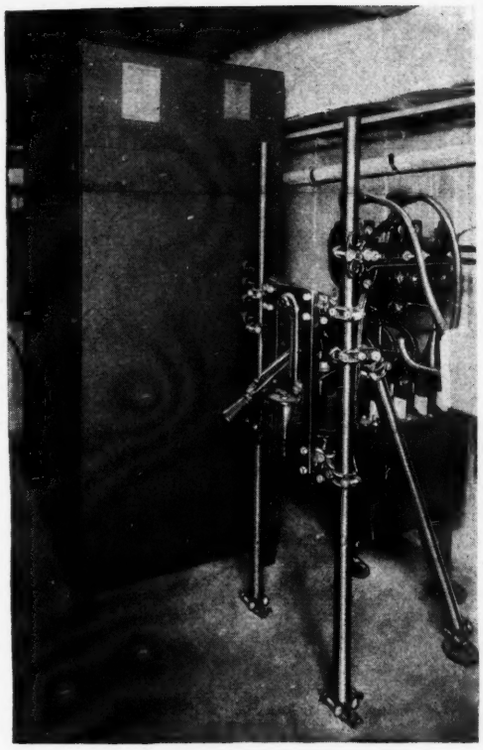
Any power-factor corrective equipment can be justified only by the savings resulting from its use. It can usually be considered that if the reduction in the power bills less the operating cost will pay for the power-factor corrective equipment in four years or less, a good investment in such apparatus can be made.

It is usually not desirable to correct the power factor to 100 per cent. Each block of corrective capacity used must be justified by the saving produced. The dollars savings per kilovolt-ampere of corrective equipment decrease as more of this apparatus is added, until a point is reached where any addition is not justified. This point must be figured for each installation. It is usually at some power factor less than unity.

The power-factor corrective equipment which is available for correcting the power factor of buildings already in operation divides itself into two main groups, syn-



Capacitors are made in small units and assembled in a frame to obtain the desired rating



120-kva. capacitor equipment

chronous condensers and capacitors (static condensers). As synchronous condensers are somewhat similar in construction to synchronous motors, their characteristics, as far as maintenance and installation, will be similar to those of a motor. Synchronous condensers have considerably higher power losses than capacitors and, also, are not as quiet in operation. The only advantage of the synchronous condenser over the capacitor, is its lower first cost in the higher capacities, and even this advantage is somewhat counterbalanced by the larger cost of installation and the larger floor space required.

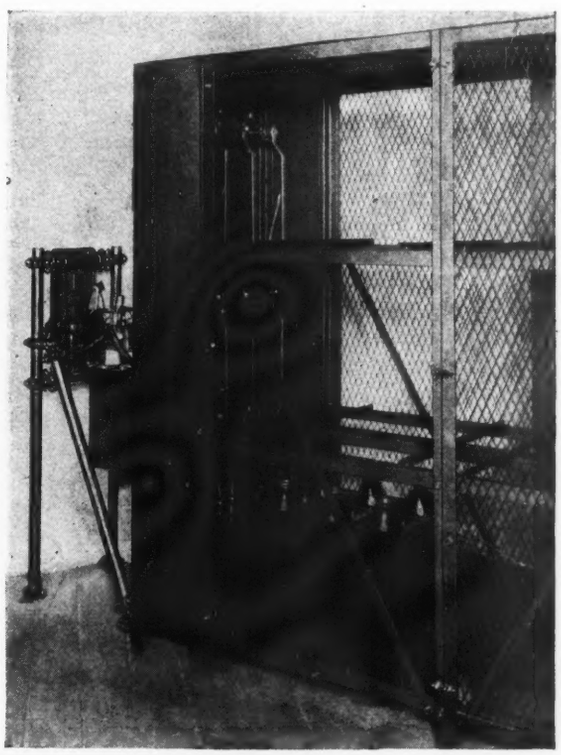
Capacitors are composed of units, each unit consisting of alternate layers of metal foil and paper assembled in a sheet-steel case, with leads brought out for connection across the line. Capacitors are available for any of the commercial alternating-current voltages between 220 and 4,600 volts, 60 cycles, inclusive. The higher-voltage units are usually cheaper than the low voltage. For this reason, the use of 2,300-volt capacitors together with step-up transformers is sometimes advocated when it is desired to correct the power factor of low-voltage circuits. The curves give the relative costs of 220-volt capacitors, 2,300-volt capacitors, 2,300-volt capacitors with transformers for use on 220-volt circuits, and synchronous condensers of the sizes usually required for buildings. These data do not include installation costs, but are intended to give a relative comparison only.

Capacitors designed for direct connection to the supply circuit are noiseless in operation, easy to install and have low maintenance, because there are no rotating parts to wear or require attention. With capacitors it is easy to increase the corrective kilovolt-ampere capacity by adding aditional units to take care of changed conditions.

A comparison between 220-volt and 2,300-volt capacitor units used with step-up transformers for the power-factor correction of 220-volt circuits will usually show that the 220-volt capacitor units will be the most economical and the most desirable to use. The 2,300-volt capacitors with transformers will require about twice as much floor space and will weigh more than double 220-volt capacitors of corresponding kilovolt-ampere capacity. The installation expense will be considerably greater because of the additional weight and because of the underwriters' requirements covering oil-filled transformers. It is necessary in many cases to build a ventilated vault in order to comply with the underwriters' requirements as regards oil-filled equipment. The 220-volt capacitor units, on the other hand, can be located either at some point near equipment operating at a low power factor, if this is convenient, or in the same room with the main switchboard.

An analysis will show that the saving in power due to the lower loses of the direct-connected capacitor unit will, in a few years, more than pay for the difference in cost between the direct-connected 220-volt and the 2,300-volt capacitors with step-up transformers. As an illustration, take the case of a 300-kva. unit, with a capital cost of $24 per kilovolt-ampere for the 220-volt capacitors and a capital cost of $18 per kilovolt-ampere for the 2,300-volt capacitors with transformers. The losses of the 220-volt capacitors will average about 2.5 watts per kilovolt-ampere, whereas the losses for the 2,300-volt capacitors and transformers will average about 35 watts per kilovolt-ampere. Assuming an average power cost of 0.7 cents per kw-hr., and the capacitors connected in the circuit continuously, the cost of the power losses in operating the 220-volt capacitor units will be $365 \times 24 \times 0.0025 \times 0.007 = \$0.15$ per year per kilovolt-ampere. The cost of the power losses with the 2,300-volt capacitors with transformers will be $365 \times 24 \times 0.035 \times 0.007 = \$2.15$ per year per kilovolt-ampere.

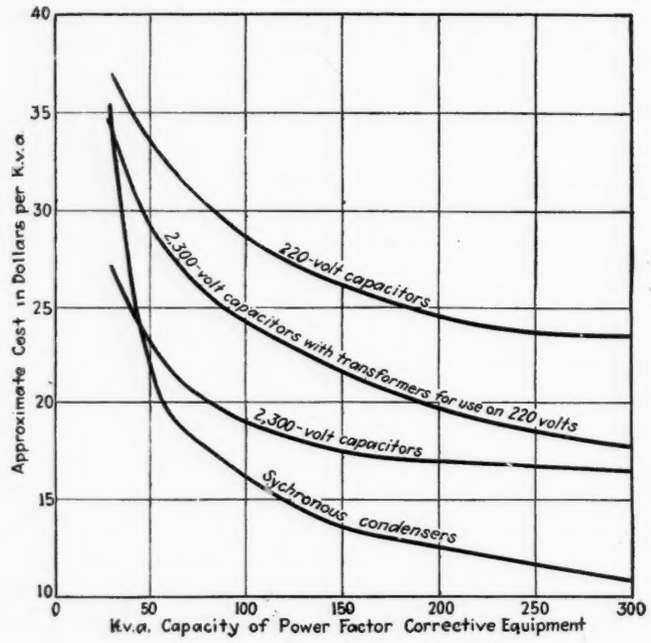
The difference in the capital cost will be $24 - 18 = \$6$ per kilovolt-ampere in favor of the 2,300-volt capacitors



Capacitor bank, rated at 240 kva., showing the arrangement of the units in the frame

with transformers, excluding freight charges and installation costs. The difference in the cost of the power losses will be 2.15 — 0.15 = $2.00 per kilovolt-ampere per year in favor of the 220-volt capacitors. This means that in about three years the savings due to the lower losses of the 220-volt capacitors would more than pay for the difference in capital cost. The actual saving would probably be more if the larger freight charges and installation costs of the 2,300-volt capacitors with transformers were added to the capital-cost figure. It can therefore be seen that the use of high-voltage capacitors with transformers for the power-factor correction of low-voltage circuits is not justified in the majority of cases.

The cost per kilovolt-ampere capacity of synchronous condensers decreases as the rating increases, and the losses also decrease as the rating of the machines increases. It so happens that for the corrective capacity



The curves show relative costs of capacitors and synchronous condensers

required for most buildings, between 30 and 300 kva., it is not economical to use synchronous condensers. In recognition of this fact, ratings of synchronous condensers within this range are not listed as standard by electrical manufacturers. The following analysis shows why a synchronous condenser is not economical to use for power-factor correction of a building power load. Assuming a 300-kva. corrective capacity required, the synchronous condenser would have a capital cost of $11 per kilovolt-ampere, excluding installation costs and losses of at least 60 watts per kilovolt-ampere. The cost of the losses per year, assuming continuous operation, would be 365 × 24 × 0.06 × 0.007 = $3.68 per year per kilovolt-ampere if the cost of power was 0.7 cents kilowatt-hour.

If 220-volt capacitors were used, with a capital cost of $24 per kilovolt-ampere and with losses of 2.5 watts per kilovolt-ampere, the cost of the power losses would be 365 × 24 × 0.0025 × 0.007 = $0.15 per year per kilovolt-ampere.

The difference in capital cost, excluding installation will be 24 — 11 = $13 per kilovolt-ampere in favor of the synchronous condenser. The difference in the annual power cost due to the losses in the power-factor corrective equipment will be 3.68 — 0.15 = $3.53. Only 3.68 yr. would be required for the savings in power due to the lower losses of the 220-volt capacitors to recover the difference in cost between the synchronous condenser and the capacitors. When the increased installation expense and the much larger maintenance required for the synchronous condenser as compared to the capacitor are considered, the actual time will be much less than 3.68 years, even if the power-factor corrective equipment is not in use continously throughout the year. The synchronous condenser as compared to the capacitor are per cent more floor space than the capacitors and will also be somewhat heavier, especially in the lower ratings.

Assuming that the local power company encourages good power factor by enforcing a power-factor clause in its contract, it is usually a simple matter to determine the capacity of corrective equipment required if the building has been in operation for several months.

The monthly power requirements in kilowatt-hours as obtained from the power company's meter readings should be used to determine the gross bill resulting when the power-factor corrective equipment is not in use. An analysis should then be made to determine the reduction in the power bills resulting from the addition of various sizes of capacitor units, and the savings in the power bill balanced against the cost of the capacitor units.

Graphic Power-Factor Meters

The most accurate method of determining the corrective kilovolt-ampere value required and its effect in increasing the power factor is to install a graphic meter. Graphic power-factor meters and also meters for indicating graphically the reactive kilovolt-amperes are available. If graphic meters are too expensive to use, then the reactive kilovolt-amperes can be estimated by making a survey of the motors and equipment in the building and their period of operation throughout the day.

In case the local power company in the enforcement of its power-factor clause in the power contract, meters the reactive kilovolt-ampere-hours as well as the kilowatt-hours and kilowatt demand for the month then a reactive-component meter can be used to determine the reactive kilovolt-amperes. In this case, it is desirable to take readings of these meters twice daily, once in the morning just after the building elevators are all in operation and once in the evening, shortly after the elevators and other motor loads are being shut down. A series of such readings over a period of two or three weeks or longer should give sufficient data to estimate the corrective kilovolt-ampere capacity required and its effect upon the building power factor.

Such an analysis will show that the first block of capacitors used will cause a much larger saving than additional blocks of capacitors, because the first block will be in service continuously and will correct not only for part of the day-time load but also during the night and week ends, when the load is comparatively light. This is especially true if there is a large kilovolt-ampere load in Neon lamps or motors at night, or if the power input to the building is metered on the high-tension side of the distribution transformer suplying power to the building, when the transformer magnetizing kilovolt-ampere value is corrected.

If the power company meters the light and power loads separately, it will usually be found that the power load will operate at a very low power factor, so that

the saving resulting from the use of capacitors for correcting the power factor will be much greater than if the power and light are metered together.

Conclusions

Where a building purchases alternating-current power from the local power company and the latter encourages good power factor, an analysis of the building power factor may show that appreciable saving in the power bills can be made by the addition of power-factor corrective equipment.

Capacitors designed for the voltage of the circuit on which power-factor correction is required, are the most economical to use in the long run and have the most desirable operating characteristics over other forms of power-factor corrective equipment. Where the power company meters the power to the building on the 2,300- or 4,000-volt side of a distribution transformer bank, then it is usually desirable to use high-voltage direct-connected capacitors to take advantage of the lower cost of these units in comparison with the cost of the 220-volt capacitor units.

The first block of capacitors installed will show the greatest dollar savings, because it corrects for the night load, as well as for the day-time load.

It is usually best to base the calculations as to the savings caused by power-factor corrective equipment on actual meter readings over a period of several months if this is at all possible.

Power-factor corrective equipment will show especially big savings in cases where a building has a large night load, where the power company meters the power to the building on the primary side of the distribution transformer, thereby including the magnetizing kilovolt-amperes of the transformer, or where the power company meters the light and power separately.

River Shannon Soon to Turn Wheels of Irish Industry*

THE River Shannon, long famed in song and story, has been harnessed to provide power for the growing industries of the Irish Free State. While for the most part the river flows through rolling, open country, between Lough Derg and the estuary there is a drop of 100 feet within a distance of twelve miles. Lough Derg is one of the three large lakes which occur in the river and provide a natural storage and stream regulation and maintain a uniform flow.

The complete project will have a generating capacity of approximately 180,000 hp., but only one of three stages is now under construction. This consists of a dam at the outlet of Lough Derg, a diversion canal nearly eight miles in length, and a power plant made up of three 38,500-hp. Francis turbines direct connected by vertical shafts to 30,000-kw. generators. These were started up on July 22.

The penstocks are of steel, almost twenty feet in diameter. The net head available varies from 81 to 109 ft. During the first stage the water in the canal will be lower than at full development, and the average head will be about 93 ft. This head will produce about 31,000 hp. per unit. Traffic in the Shannon River will be taken care of by two locks, which will raise the boats from the open tailrace to the diversion canal.

*From Stone & Webster *Journal*, July, 1929.

Treat Low-Voltage Circuits With Caution

By I. L. Kentish-Rankin

"TREAT all electric circuits as dangerous," is always a safe dictum. The reason for not specifically mentioning low-voltage circuits is because one of a low voltage may become high voltage for any one of many reasons. The only way to treat any electric circuit is to treat it as if it were dangerous, because any electric circuit is dangerous, since the danger is not only dependent upon voltage, but is, ultimately, dependent upon the flow of current. This, in turn, depends on the resistance of this circuit—which means the ground, the contact resistance of the human body, the condition of the human body, etc. Further whether the current flowing through the human body is dangerous for a specific case depends upon where the current flows in respect to the heart and respiratory system, as well as upon the condition of the heart and its ability to withstand an electric shock.

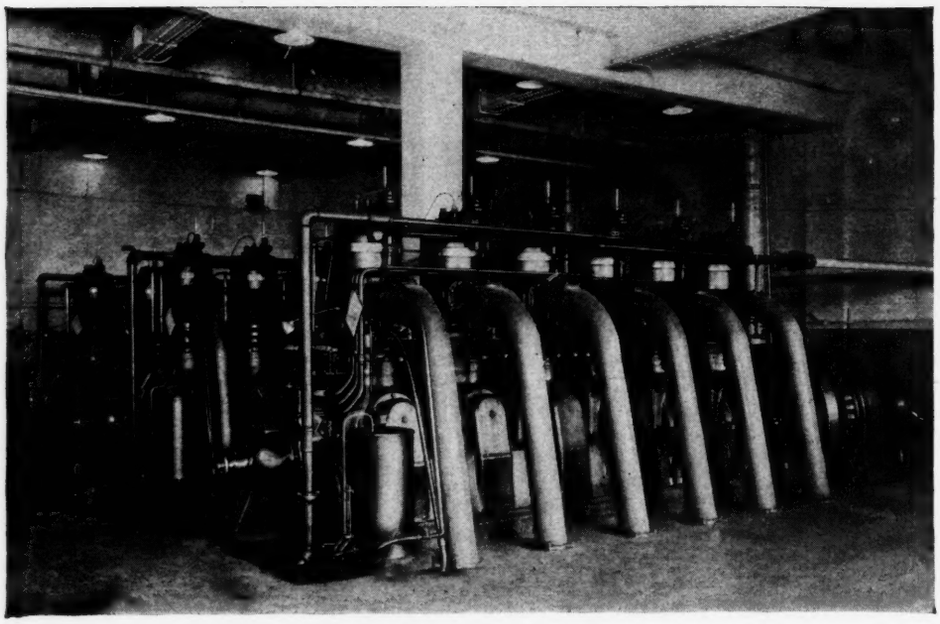
It is dangerous to refer specifically to "low-voltage circuits," because whether the circuit is a low-voltage one depends largely upon who is discussing the subject. Public utilities refer to anything below 2,400 volts as "low voltage," meaning that it is secondary to the high-voltage transmission line, which may range from over 100,000 volts to the typical 400 to 600, 9,000, 12,000 and 20,000 volt underground cables. For ordinary industrial and powerhouse work, 240 volts and below are considered low-voltage circuits. Many men have been killed with current from 110-volt circuits. A number of conditions may combine to cause 110 volts to become dangerous. In other cases, the 110-volt circuit may be raised to a potential many times its nominal value to earth. There is only one safe practice with any electrical circuit, and that is to consider it as dangerous.

In the power house, ordinarily, the greatest hazard is not from the high-voltage circuit protected by barriers, notices, compartments or guards. The greatest danger is from the low-voltage circuit and, in particular, the portable lamp cord and electric light socket. The low-resistance ground on the power house, plus the extension cord as used for making repairs, inspection and general portability make a deadly pair which have caused many deaths.

Electric circuits around power plants are especially dangerous, because circuit resistance tends to be exceptionally low. Wet ashes, water pipes, steel work embedded in soil—all these things create a low-resistance "ground," or "earth," through which current can flow readily, even at low potential.

When you have low surface or contact resistance combined with a low resistance earth or ground conditions are ideal for maximum current flow, with minimum potential of the circuit and therefore maximum hazard.

The hazards to which I refer particularly are the electric drill and other forms of electric tools and to portable lamps and anything else where frayed insulations, defective sockets and other conditions may give a rise to leakage of current. Standing upon wet ashes, on stoker bars, in boilers, against power plant channel iron and other obstacles creating a good earth are particularly dangerous. Care and caution are the best safeguards against using equipment having defective insulation. Treat every electric circuit as a danger and govern yourself accordingly.



The Selection of Diesels

Depends Upon Load Conditions

By L. A. Pease
Assistant Director of Engineering, Fairbanks, Morse & Company

IF A DIESEL power plant is to attain the highest possible economy, the load conditions under which it is to operate must be given a careful study and the capacities of the individual units must be coordinated with the load conditions.

The characteristics of the Diesel usually permit a choice of combinations of units and of unit sizes, to give best results. The more that is known about the detailed demands of the system where more than one unit can be used, the more closely will the ideal combination of units be obtained.

The fact that the Diesel's fuel economy is practically the same at three-quarter load as it is at full load, gives a considerable latitude in choice of unit sizes and also permits the load to be distributed over a number of engines, which can be started and stopped as the demands come on or off the system. The starting and stopping of these engines is simple; not much more than the starting and stopping of an automobile engine, and there are no stand-by operating losses when the unit is shut down.

In order to show the successive steps that should be followed in selecting the proper size Diesel for a plant, a typical case will be selected for analysis. The problem is to design a Diesel-electric plant to supply electricity and water for a factory.

All power for lighting, pumping, and driving machines, heat treating, testing and carbonizing is to be supplied by the engines. The plant will be operated 10 hours daily, 300 days per year, while the pump motor and miscellaneous lights will be carried 365 days a year, 24 hours a day. The minimum demand during the year is 1,225 kw., the average hourly load during the year is 428 kw. and the annual load factor, that is, the average hourly load during the year divided by the maximum hourly load, is 35 per cent. The annual power consumption, 1,125 kw. x 8,760 hrs. per year x .35, is 3,750,000 kw.-hr. On holidays and Sundays the load, with a maximum of 230 kw., will average 150 kw., and the night load 500 kw. It is assumed that the load will increase 10 per cent yearly for 5 years.

In determining the size of the engine units it is necessary to study closely the maximum demands on the heavy days, as this will govern the total plant capacity, and the demands on the lighter days, as this will tend to indicate some of the sub-divisions of the units. In this plant the hourly consumption for a typical day during the heavy load period is shown in Fig. 1. This will be considered our maximum day. A similar character of load is assumed for a typical day during the lighter load periods, but with the maximum hours approximately 70 per cent of the heavy-day load.

The next step is to plot the generator capacity that would readily take care of this load and still not have much excess over actual demands.

This capacity could be provided for by installing three generator units, two of about 580 kw., or 840 hp. each, and one of 240 kw., or 360 hp. The small unit could carry the load from 6 p.m. until 6 a.m. One

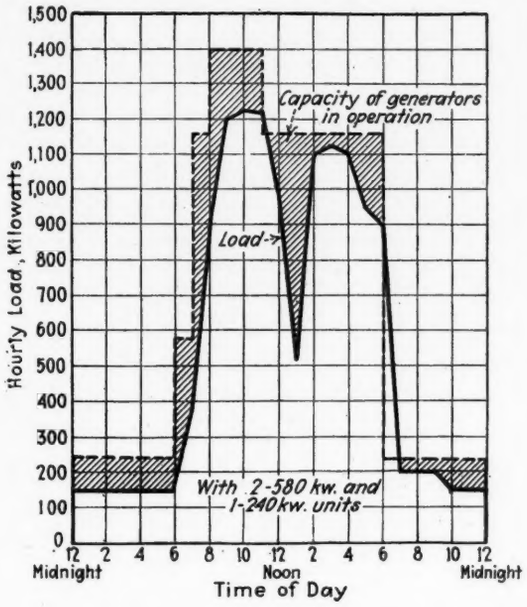


Fig. 1—Carrying the plant load with three Diesels

580-kw. unit would then carry it from 6 to 7 a.m. and two 580-kw. units from 7 to 8 a.m., at which time the third unit would be added until 11 a.m. From this time on until 6 p.m. the two 580-kw. units would suffice.

From this date, the plant load factor and the individual engine load factors are computed, for it is the individual engine load factor that determines the economy at which the unit, and, therefore, the plant, can operate. This factor is the ratio of the actual average power output for a given period divided by the generator capacity in operation for that period. Tabulation of values obtained from Fig. 1 will show the engine load factor, or, in other words, the proportionate capacity at which it operates throughout the day.

The daily load factor is the average hourly load divided by a maximum load, or, $\frac{13,585}{24} \div 566 = 0.46$, or 46 per cent. This shows that the maximum load, or demand, was used for a time equivalent to 46 per cent of the total time of the day. The plant load factor is figured by dividing the actual average load of 566 kw. by 1,400, the maximum plant capacity, giving 0.404, meaning that the plant engine capacity is used 40.4 per cent of the available time of the 24 hours.

The average load on the individual units during the time that they were operating for the day is close to 80 per cent of their rated capacity, and consequently the engines used throughout the day for this load run at approximately full-load fuel economy.

Tabulation of Estimated Monthly Loads

Month	Day	Max. Demand, Kw.	Output Kw.-Hr.	Average Load, Kw.	Monthly Load Factor, Per Cent
Jan.	31	1225	350,000	472	38.5
Feb.	28	1175	345,000	513	43.5
Mar.	31	1100	345,000	465	42.3
Apr.	30	1100	325,000	450	40.8
May	31	950	300,000	405	42.7
June	30	950	275,000	381	40.2
July	31	1000	275,000	370	37.0
Aug.	31	1000	275,000	370	37.0
Sept.	30	1100	300,000	417	37.8
Oct.	31	1100	300,000	405	36.8
Nov.	30	1150	310,000	430	37.3
Dec.	31	1200	350,000	472	39.3
Total			3,750,000	428	35

Full-Load Fuel Economy

This shows that the load factor for the day is 46 per cent against an average for the year of 35 per cent; this is quite characteristic, as few industrial plants run at the same rate throughout the entire year. If it were a pumping plant, a flour mill, a tube mill or a linseed mill, the annual load factor could be quite close to the daily load factor, but only if the plant is run seven days a week. In large central stations where the load is allotted

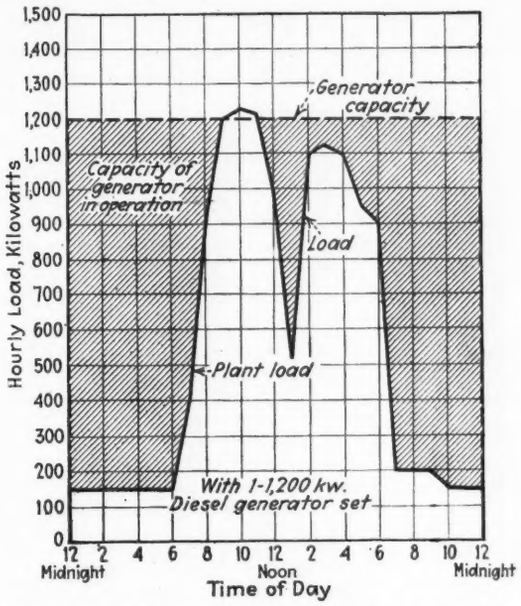


Fig. 2—Effect of installing a single engine

to them from a large diversified system, it will be found that high load factors exist.

Assuming that a complete year's record is available, it is still probable that the load will be entirely different during subsequent years. Choice of units, therefore must be based upon judgment obtained through experience. The plant installed with adequate capacity and with sufficient reserve for future expansion, and set up so that the loads are quite economically carried, will operate at a maximum efficiency provided the load does not radically change in the future. Usually as the load increases in a plant of this type the load factor gets better rather than worse, as in most manufacturing organizations of today the tendency is to increase the load factor on the power system.

A study of these data indicates that a number of other combinations of units could be used, such as a 1,200-kw. set. This would mean, as indicated in Fig. 2, that the unit would need run the full 24 hours. To overcome this a 240-kw. unit could be added for the night load. Another solution would be to operate three units during the heavy load, by day; and one for carrying the light load, by night.

At this time the load is small enough to be carried by a single unit. This is shown in Fig. 3.

The total daily kilowatt-hour output with the 1,200-kw. unit in Fig. 2 would still be 13,585 with an average of 566 kw. per hour. The load factor of the plant would be, of course, the same as before: that is, the average load divided by the maximum hourly load. The plant factor, however, would change very materially. This would be 556 kw. ÷ 1,200 kw., or 47.1 per cent. The engine, then, would be operated on an average load of 47 per cent of its capacity for the day. During the hours from 6 p.m. to 6 a.m., it would produce 1,950 kw-hr., or an average of 162 an hour. This is only 13.5 per cent of the generator capacity. Consequently, operation would show a low fuel economy. From 6 a.m. to 6 p.m. the unit would produce 11,635 kw-hr., with an average of 970 kw-hr., or 81 per cent of its capacity, thus giving good fuel economy during only one half of the day. It is apparent at once that it would be a poor selection for this plant. There is no reserve for breakdown, and as no unit can run continuously without attention it would be entirely out of the question, to say nothing of its low fuel economy.

A 250-kw. unit could be added to run from 6 p.m. to 6 a.m. and thus increase the load on the operating unit from 14 per cent for the night period to 162 ÷ 250, or 65 per cent, giving a better fuel economy and at the same time permitting a period of shutdown for the large unit for repairs and maintenance. This combination would give practically the same economy as the first choice, but in case anything happens to the large engine, the entire factory would be shut down, while if the

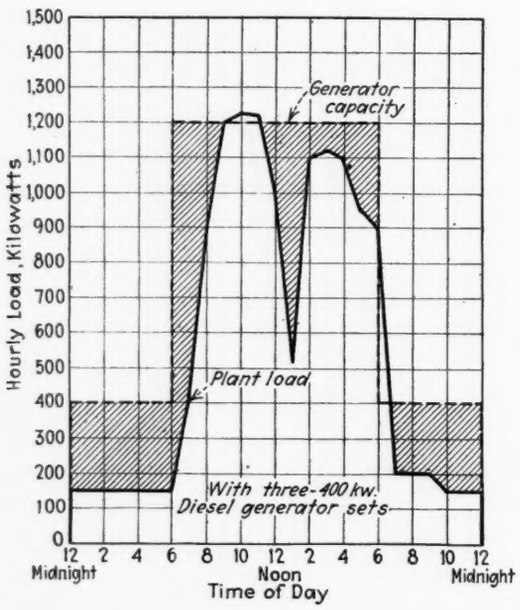


Fig. 3—Conditions with three 400-kw. units

units were divided further the important and major part of the factory could operate while repairs were being made on one of the units.

Examination of Fig. 3, showing operation with three 400-kw. units, reveals that on the night load one 400-kw. unit would be run, with an average load of 152 kw., or 40.5 per cent of the generator capacity. During the day three units would be operated, with an average load of 970 kw., which equals 81 per cent of the generator capacity. The three 400-kw. units would make a good operating plant, but the individual unit load factor would not be quite as good as that shown in the first example.

With the plant load increasing 10 per cent a year for five years, with the arrangement in Fig. 1 a 580-kw. unit would need to be installed during the second year. This would take care of the increasing load for the five years. At the same time it would serve as a spare unit, which is standard practice in all organizations where continuity of service is a major factor. If the 400-kw. units of Fig. 3 were chosen it would be necessary to add a fourth unit the first year, and a fifth unit at the end of the third year, as it is good practice to have excess capacity and not require overloading of the units. If the 1,200 kw. units, Fig. 2, were installed, additional

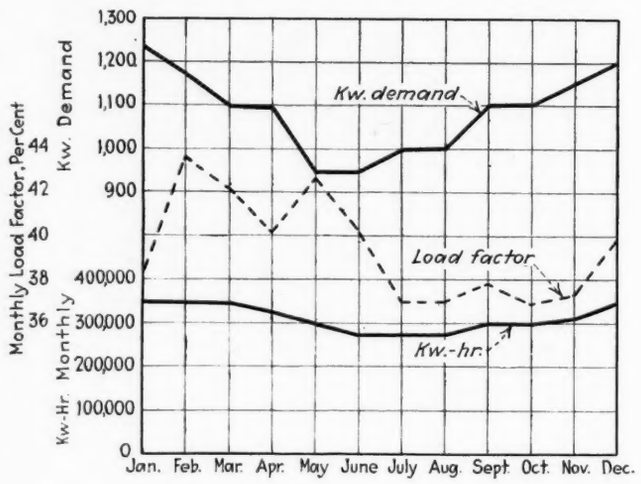


Fig. 4—Monthly demand, load factor and output for a year

equipment would have to be placed at once to take care of the additional load, as well as to enable economical operation during the light-load periods.

It is assumed here that during December, January and February the overlapping of the lighting and power loads creates the greatest demand. At the same time the load factor may be lower than during some of the other months, the load factor in each case being taken as the average hourly load for the month divided by the maximum load for the month. The annual load factor is smaller than the average of the monthly load factors because the maximum load for the year, which occurred in January, is used.

The data given in the tabulation are shown graphically in Fig. 4. It is apparent from this chart that the power consumption and demand is not constant, the power fluctuating from 275,000 to 350,000 kw.-hr. per month, a variation of 27½ per cent above the minimum month, while the demand fluctuates from 950 kw. to 1,225 kw., or 29 per cent, above the minimum month. The highest monthly load factor, however, is only 43 per cent, with an annual average load factor of 35 per cent, showing that any lowering of the peak hours or increasing of the output in useful work will lower the cost per kilowatt-hour. This is due to the fact that such items as labor, insurance, taxes, interest on the investment etc., do not increase with increased load. This same line of reasoning can be used, modified as may be necessary, for choosing units for almost any type load, whether it be for pumping water, running a flour mill, operating a shovel or dredge or driving a mill directly.

High-Heat Basis Should Be Used to Figure

BOILER EFFICIENCIES *with* NATURAL GAS

By Haylett O'Neill

THERE is a wide misunderstanding among both users and manufacturers of gas burners as to possible boiler efficiencies with natural gas. In certain parts of Europe efficiencies are based on the "low" heating value, while the accepted American practice follows the A.S.M.E. code and uses the "high" value. Certainly, every producer of natural gas uses the "high" value in discussing the heating value of his product to his customers, and the calculation of efficiencies on the two different bases has led to misleading practices.

Some manufacturers, while trying to eliminate the word "low," have substituted the term "net heating value," which, in addition to being outside of the A.S.M.E. code tends to obscure the true meaning of efficiency. It is safe to say that to the average purchaser, unless he be informed specifically otherwise, the word "net" means that part of the gas that, in spite of pipe, valve and drain leaks, finds its way into the boiler furnaces, and he is not aware of the fact that the boiler efficiency as calculated by the A.S.M.E. code is from 10 to 12 per cent lower than that calculated on the basis of "net heating value."

He does not stop to think that the chimney loss of heat due to burning the hydrogen content of the gas to water, which is evaporated and superheated to the flue-gas temperature, cuts down the available heat to less than 90 per cent of the calorimetric value. It is true that occasional reference is made to "the water loss," but this is taken to mean the loss due to wet gas—that is, gas saturated with water vapor—a conception not founded on fact. In other words, a boiler efficiency of 82½ per cent with natural gas based on the net heating value, while sounding high, means nothing more than 72 to 73 per cent when calculated according to the A.S.M.E. code. When used by an unadvised salesman, it sometimes results in the loss of an order to a reliable manufacturer who has figured on the correct basis.

In order to show the absurdity of obtaining efficiencies of over 80 per cent with gas, based on the A.S.M.E. code, the calculations given in the tabulation were made; the natural gas was made up of 98 per cent Methane and 2 per cent nitrogen by weight.

TABLE I—COMBUSTION WITH NO EXCESS AIR

Constituents of Fuel	Wt. per Lb. of Gas	O_2, Lb.	Air, Lb.	Products of Combustion— CO_2	O_2	H_2O	N_2
Methane	0.98	3.92	16.96	2.69	...	2.22	13.02
Nitrogen	0.02	....	.....	....	...	....	0.02
Total	1.00	3.92	16.96	2.69	0.0	2.22	13.04

TABLE II—COMBUSTION WITH EXCESS AIR

Products of Combustion	Wt. per Lb. Gas No Excess Air	10 Per Cent Excess Air
CO_2	2.69	2.69
O_2	0.0	0.392
N_2	13.04	14.34
H_2O	2.22	2.22

With 10 per cent excess air the dry-gas weight is 17.422 lb. and the H_2O weight is 2.223, making a total flue-gas weight of 19.645 lb. The calorimetric heating value of the gas is 1,045 per cu.ft., or 24,800 per lb. The specific heat of dry flue gas is 0.24 and the specific heat of superheated steam is 0.48. Assuming an air temperature of 70 deg. F. and a flue-gas temperature of 500 deg., the heat balance works out as shown in Table III.

TABLE III—HEAT BALANCE PER POUND GAS

	B.t.u.	Per Cent
Dry gas loss + 17.42 × (500 — 70) × 0.24	1,798.7	7.25
Loss due to burning hydrogen (evaporating and superheating H_2O at flue-gas temperature), 2.223 {(212 — 70) + 970.4 + 0.48 × (500 — 212)}	2,788.8	11.25
Radiation and unaccounted-for losses, estimated for average plants at 5 per cent	1,240.0	5.0
Total losses per pound of natural gas	5,827.5	23.5
Total available heat to steam	18,972.5	.....

The efficiency is then $\frac{18,972.5}{24,800}$, or 76.5 per cent, based on the A.S.M.E. code. Had the efficiency been based on the net heating value, it would have been calculated thus: Net heating value is 22,410 B.t.u. per lb. and the efficiency becomes $\frac{18,972.5}{22,410}$, or 84.7 per cent. In other words, while this efficiency may appear higher on paper it does not reduce the customer's fuel bill one cent and, unless carefully defined, leads to confusion and disappointment on the part of the burner customer.

The efficiency of gas and of fuel oil based on net heating values under similar combustion conditions is nearly the same, but the efficiency of oil based on the A.S.M.E. code is about 4 per cent higher than with gas. There is, however, a widespread, though erroneous, idea that the combustion of gas is inherently more efficient than that of oil. The reason for this feeling is undoubtedly the somewhat indiscriminate use of the net heating value of the fuel by certain gas-burner manufacturers, while the gross value is generally used for oil burners, just as for coal-burning apparatus.

The proof of the foregoing may be found in the operating statements of the larger utilities in the Southwest, where both fuels are alternately burned under equally ideal conditions of settings, good operation and maintenance. The efficiencies are regularly about 4 per cent higher with oil fuel.

Although this is true, there are certain practical considerations which tend in many plants to wipe out this inherent advantage of oil. In fact, there are some plants that do show a higher efficiency with gas than with oil. Gas burners are more easily controlled and maintained in their best condition. The best of oil burners is subject to drooling, carbonizing and wear, which gradually increases the losses. In the larger plants, with expert maintenance and operation, these losses are minimized.

U. S. Navy Uses SYMBOLS *To Identify Lubricating Oils*

BY LIEUT. C. A. GRIFFITHS
Bureau of Engineering, Navy Dept.

A SYSTEM OF SYMBOLS *based on viscosity and use has been substituted for the misleading designations, "light," "medium" and "heavy." This system is applicable to any power plant, and its more general adoption would result in greater uniformity of lubricants supplied.*

FREQUENTLY a so-called "light" lubricating oil produced in one refinery or from one crude is practically the equivalent of a "medium" or "heavy" oil from another refinery or a different crude. A "medium" oil from one crude may have characteristics approximating those of a "heavy" oil from another crude, yet the purchaser may assume that, as far as the respective properties are concerned, the two oils are alike. Thus the terms "light," "medium," "heavy," etc., have no accurate significance for anyone but the manufacturer of the particular oil.

The need of a standard method of classifying lubricating oils in the navy has led to the adoption of a symbol system of identification. If an oil desired for a certain lubricating service is ordered by symbol number, the number is descriptive of the particular kind of oil regardless of the manufacturer's designation. All refiners and dealers in lubricating oils bidding on naval contracts are familiar with and are required to use this symbol system in describing their oils.

All lubricants have certain traits in common, but variations in these characteristics determine the body, viscosity, oiliness and fluidity of the oil. In developing standardization the most important variable must be taken as the fundamental on which to classify different oils. In the refining of a crude the weight (Baumé) assumes primary importance, but when applied to a lubricating oil after refining, weight loses its meaning. As a general rule, other things being equal, a napthene-base oil is heavier than a paraffin-base oil. The color of an oil is sometimes, but not always, an indication of degree of refinement and cleaning. It bears no relation to the physical properties. The tendency of an oil to completely "wet" a surface is described as its "oiliness." This characteristic is possessed to a greater degree by vegetable oils than by mineral oils, but it bears no relation to the other more important characteristics which are common to both classes. Consequently, the selection of a fundamental depends not on the weight, nor the color, nor the base of the crude, but on the viscosity. The oil has a twofold duty, namely: (1) to satisfactorily lubricate by maintaining an oil film, and (2) to dissipate the heat of friction. Only an oil having the correct viscosity at the running temperature can effectively accomplish this dual purpose.

Because of the importance of viscosity in the selection of a lubricating oil, the standardization on a viscosity basis was an evident necessity. Minimum requirements for other characteristics had, naturally, to be established; but for the many different oils the viscosity was the predominating variable which was standardized.

The symbol system consists of a four-digit numeral, of which the first digit designates the class of oil on a basis of its use, and the last three digits indicate the viscosity in seconds (Saybolt universal viscosimeter). Proper lubrication for practically all machinery can be found within the range of symbols, from ice machines, through the forced-feed oils to heavy marine cylinder oils. The classes of oils symbolized by the first digit are:

1. Refrigeration oils.
2. Forced-feed and motor-cylinder oils.
3. Aviation forced-feed and motor-cylinder oils.
4. Compounded marine engine oils.
5. Mineral marine engine and cylinder oils.
6. Compounded steam cylinder oils (tallow).
7. Compounded steam cylinder oils (lard or tallow).
8. Compounded air cylinder oils.
9. Electrical transformer oils.

The viscosity, shown by the last three digits, is that obtained at the following temperatures: For refrigeration oils, forced-feed and motor-cylinder oils (except aviation oils), for compounded air cylinder oils, and for transformer oils, 130 deg. F.; for aviation motor-cylinder oils, compounded marine engine and cylinder oils, and mineral marine engine and cylinder oils, 210 deg. F. The table shows the development of the eighteen oils

TABLE SHOWING THE DEVELOPMENT OF THE SYMBOL SYSTEM FOR LUBRICATING OILS

First Digit	Class	Last 3 Digits	Complete Symbol	Old Designation	Viscosity at 130° F.	Viscosity at 210° F.
1—	Refrigeration oil	075	1,075	Ice machine	65– 85	
2—	Forced feed and motor-cylinder	110	2,110	Light	100–115	
2—	Forced feed and motor-cylinder	135	2,135	Medium	125–145	
2—	Forced feed and motor-cylinder	190	2,190	Heavy	180–200	
2—	Forced feed and motor-cylinder	250	2,250	Extra heavy	240–260	
2—	Forced feed and motor-cylinder	310	2,310	Ult. heavy	300–320	
3—	Forced feed and motor-cylinder	080	3,080	Avia, winter	.....	75– 85
3—	Forced feed and motor-cylinder	100	3,100	Avia, summer	.....	90–110
3—	Forced feed and motor-cylinder	120	3,120	Avia, heavy	.....	115–125
4—	Engine oils	065	4,065	Marine, comp	.....	Min. 65
5—	Engine oils	065	5,065	Marine, mineral	.....	Min. 65
5—	Engine oils	150	5,150	Steam cyl., mineral	.....	135–165
5—	Engine oils	190	5,190	Steam cyl., superheat	.....	160–220
6—	Engine oils	135	6,135	Steam cyl., comp	.....	120–150
7—	Engine oils	105	7,105	Steam cyl., comp	.....	95–110
8—	Air compressor oil	135	8,135	Air cyl., comp	125–145	.....
8—	Air compressor oil	190	8,190	Air cyl., comp	180–200	.....
9—	Electrical oil	045	9,045	Transformer	40– 45	.....

on the navy list by symbols according to class of service on a viscosity basis.

The symbol series of paraffin-base, force-feed and motor-cylinder lubricating oil within the usual working range of temperature of marine machinery plotted against viscosity (Saybolt universal) is shown in Fig. 1. Fig. 3 shows the same series plotted on logarithmic paper. For small increments of temperature within the working

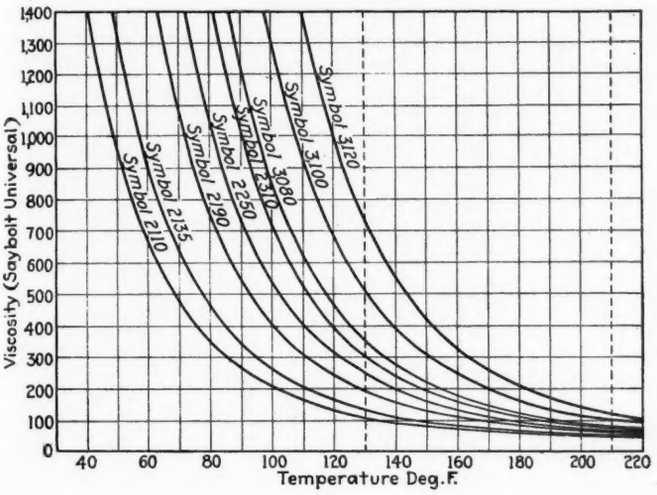


Fig. 1—Temperature-viscosity curves of forced-feed and motor-cylinder oils of paraffin base

range, the curves on logarithmic paper are, for all practical purposes, parallel lines. Actually, they are not parallel, as they have a common meeting point at the temperature of vaporization, which in the case of the paraffin series lies in the neighborhood of 470 deg. and for napthene-base oils about 420 deg. The convergence of the curves is observed more clearly in Fig. 1. Parallelism can be assumed only for oils of the same base, same process of refinement, or proportionally similar blends of these oils, and then only in the working range.

It is seen from Fig. 2 that symbols 2110 to 3120 inclusive cover any desired viscosity for any type of machinery requiring forced-feed lubrication. Thus, if it is decided that for a small, high-speed, comparatively light weight turbine running with normal bearing temperatures of 140 deg. a viscosity of about 150 will be satisfactory, the correct oil will be symbol 2190. Should ths machine operate with the bearing temperatures reduced to about 120 deg., the same viscosity would be obtained by using the symbol 2135 oil.

Fig. 2 shows two groups of curves; Group 1 of symbol 2190 oil, and Group 2 of symbol 3100 oil. Each group is for the same symbol oil, but of oils having different natures. Curves *a* are of napthene-base oils from California crudes; curves *b* are of the paraffin-base oils from Pennsylvania crudes; and, curves *c* represent a blend of napthene- and paraffin-base oils. A brief description of the characteristics of the symbol oils follows:

1075—Mineral oil having extreme fluidity, especially at low temperatures; may have comparatively low flash point; must have low pour point; must not emulsify.

It is necessary that considerations other than viscosity involving the use of a correct lubricant be investigated. Lubricating oils for forced-feed applications should have the following general characteristics in addition to viscosity considerations:

(a) They must resist oxidation. Oxidation, caused by precipitation of hydrocarbon oxides, which takes place whenever oil comes in contact with air, results in the formation of sludge.

(b) They must resist emulsification. An emulsification is a mcehanical mixture of oil and water which hastens oxidation and prevents formation of an oil film. It may be either a simple or a permanent emulsion. Oil in a simple emulsion with water will settle out rapidly, but if emulsified in the presence of dirt, impurities in the oil, or sludge, it will become permanent and the lubricating property of the oil will be lost.

(c) They must contain no free sulphur nor corrosive agent.

(d) Flash and fire points must be sufficiently high to preclude any danger from ignition of explosive vapors.

(e) The oil must be fluid at low temperatures. Fluidity is essential at low temperatures to insure ease of handling, pumping and circulating in cold weather.

(f) They must contain no vegetable nor animal oils, which oils when subjected to the heat and pressure of operating conditions develop an acid reaction which is not only harmful to metal surfaces but hastens oxidation and the formation of sludge.

(g) They must contain no free acid. Free acid in a mineral oil indicates that mineral acids in the crude have not been entirely removed during refinement, or that animal or vegetable oils are present.

(h) The evaporation losses at working temperature must be low.

(i) There must be a minimum amount of carbon residue on evaporation.

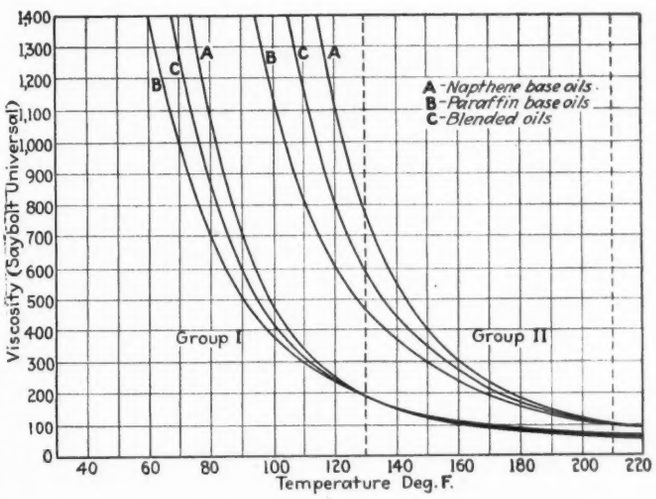


Fig. 2—Temperature-viscosity curves giving comparison of naphthene-base, paraffin-base and blended oils

(j) They must contain a low percentage of unsaturated compounds. These are insoluble asphalts which cause the formation of solid carbon particles and have a tendency to separate out during work and form a sludge.

(k) There must be no radical increase in the viscosity of the oil during use. An increase in viscosity is due to a combination of the above-mentioned defects in refining, oxidation, formation of sludge, and separation of carbon.

Symbol 2110—Mineral oil with a neutral reaction. Total sulphur to be not over 0.50 per cent. Not over 0.50 per cent carbon residue of a loose and flaky nature. Must completely settle out in an emulsion test in 30 min. Unsaturated compounds must not exceed 10 per cent. Flash point not less than 325 deg. F. Pour point not over 35 deg. F.

2135—Similar to 2110 oil except that unsaturated compounds should not be over 12 per cent; flash point above 335 deg. F.

2190—Similar to 2135 oil except that unsaturated compounds should not exceed 14 per cent; flash point above 345 deg. F.

2250—Similar to 2190 oil except that unsaturated compound should not exceed 15 per cent; flash point above 355 deg. F.; carbon residue not over 1 per cent.

2310—Similar to 2250 oil except that unsaturated compounds should not exceed 18 per cent; flash point above 365 deg. F.; should completely settle out in an emulsion test in 60 min.

3080—Similar to 2310 oil except that unsaturated compounds should not exceed 30 per cent; flash point above 390 deg. F.; carbon residue not over 1.50 per cent; total sulphur not over 0.75 per cent; pour point below 15 deg. F.

3100—Similar to 3080 except that pour point should be not greater than 25 deg. F.; flash point not less than 410 deg. F.

3120—Similar to 3100 except that pour point should be less than 30 deg. F.; flash point above 450 deg. F.

Engine Oils

Straight mineral engine oils, in general, should have the same degree of refinement that is given forced-feed oils. Compounded-engine oils consist of mineral oils to which has been added a small percentage of vegetable oil. These contain greater adhesive properties than straight mineral oils. This feature is used to advantage in wick-feed lubrication of large, slow-moving machinery.

When vegetable oils are compounded with mineral oils emulsification with water will take place. Advantage is taken of this property in lubricating applications where water may be used directly on a bearing to cool it. The combination of adhesion and emulsification will permit the use of water without danger of destroying the lubricating film on the wetted surfaces by washing away. Vegetable oils will not stand continuous working, for at high temperatures and pressures the oil will break down and form objectionable gums.

Steam cylinder oils, used on pump and engine rods, must be extremely low in evaporation losses and high in flash point. Other characteristics which would be detrimental to a forced-feed oil are more or less unimportant for piston rod lubrication for the reason that the oil once used is not regained and refinement to prevent increase in viscosity and polymerization under continued work is unnecessary.

Symbol 4065—A mineral oil compounded with 10-20 per cent vegetable oil having a neutral reaction. This must remain in an emulsified state for at least an hour and retain a good proportion of flow in a wick-feed test at the end of two weeks test. Flash point about 360 deg. F.; pour test about 35 deg. F.

5065—A straight mineral oil having no fixed or fatty oils compounded with it. Total sulphur not over 0.75 per cent; pour point below 35 deg. F.; flash point above 345 deg. F. It should remain in an emulsified state for not less than 30 min. and retain at least 30 per cent of flow at the end of 14 days in a wick-feed test.

5150—A mineral steam cylinder oil having not over 4.5 per cent carbon residue of a loose and flaky nature. Total sulphur not over 0.50 per cent; pour point below 50 deg. F.; flash point above 490 deg. F. It must have extremely low evaporation losses.

5190—This is a mineral steam cylinder oil similar to symbol 5150 except that the flash point should be above 525 deg. F to permit use with high temperature superheat steam.

6135—Compounded steam cylinder oil (a mineral oil compounded with 5-7 per cent tallow oil). Not over 2.50 per cent of loose and flaky carbon residue; extremely low evaporation losses; total sulphur not over 0.50 per cent; pour point below 60 deg. F.; and flash point above 475 deg. F.

7105—Compounded steam cylinder oil (a mineral oil compounded with 9-10 per cent of tallow or lard oil). Similar to 6135 except that there should be not over 2.0 per cent carbon residue of a loose and flaky nature; pour point below 40 deg. F.; flash point above 450 deg. F.; total sulphur not over 0.50 per cent.

Air Compressor Oils

The high temperature of compressed air in an air compressor cylinder, together with the presence of moisture due to condensation of vapor destroys the oil film on the cylinder walls. To counteract this it is important that air compressor oils be compounded so that the adhesive property of the compounding oil will not permit the water to wash away the oil film. Because of the temperatures of the highly compressed air these oils must have a sufficiently high flash point to prevent the formation of explosive vapors and the ignition of carbon deposits. The carbon residue must be correspondingly low and the basic mineral oil must be well refined.

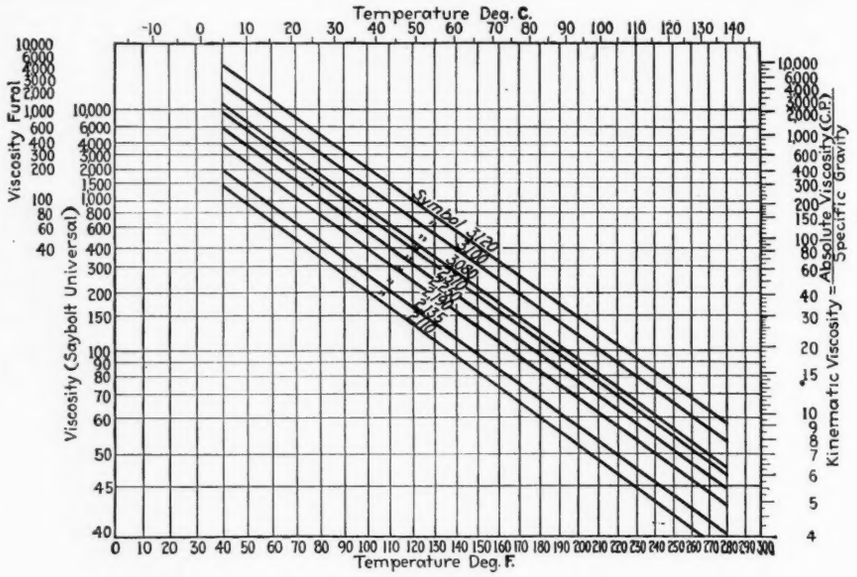


Fig. 3—Temperature-viscosity curves for forced-feed and motor-cylinder oils plotted on logarithmic scale

8135—Compounded air-cylinder oil (a mineral oil compounded with 2-4 per cent lard oil). Other characteristics similar to 7105 oil except that carbon residue should not be over 0.50 per cent; flash point above 335 deg. F; pour point below 35 deg. F.

8190—Compounded air-cylinder oil similar to 8135 except that flash point should be above 345 deg. F.

Electrical Oils Must Not Absorb Moisture

The most important characteristics of electrical oils are: The dielectric strength must be high, and they must possess exceptional resistance to moisture absorption. A slight amount of moisture in a transformer oil will reduce the dielectric strength to a point where current will readily flow.

9045—Electric transformer oil; a straight mineral oil having a high dielectric strength; an extremely rapid settling out in an emulsion test and a flash point not less than 270 deg. F.

Practically all shipboard machinery as well as stationary plant machinery will find correct lubrication in

the foregoing listed oils. Briefly indicated, typical uses for these different symbol oils are as follows:

Symbol 1075—Ice machine cylinders; pneumatic tools; hydraulic systems; household refrigerators; quenching oil.

2110—Main bearings of Parsons marine turbines; small turbo-generators; motors and dynamos; small miscellaneous machinery; line shafting; quenching oil.

2135—General machine oil; larger turbine-generators; miscellaneous machinery oiled with oil cups; small gasoline engines in cold weather; rotary pumps; passenger motor cars.

2190—Large turbines; marine auxiliary machinery; inclosed ice machines of the crank-case type; passenger motor cars; small two- and four-cycle Diesel engines; reduction-geared turbines; medium-sized water-cooled gasoline engines; farm lighting outfits operating under cold weather conditions.

2250—Medium-sized Diesel engines; motor cars and trucks; motor boat gasoline engines; small- and medium-sized two- and four-cycle air injection Diesel engines and auxiliary compressors; stationary gas engines.

2310—High-compression gasoline engines; motor cars and trucks; stationary gas and oil engines; power cylinders of medium- and high-speed Diesel engines.

3080—Aircraft engines; high-speed gasoline engines; Diesel engine air-compressor cylinders; single-stage air compressors; ring-oiled bearings of small turbine-generators without cooling systems.

3100—Aircraft engines; high-speed and high-compression gasoline engines; motor trucks; motor boats; motorcycles; large Diesel engine cylinders.

3120—Aircraft engines; cylinders of Diesel engines of 3,000 hp. or over; gasoline and Diesel engines in high-speed motor boats; tractors.

4065—Reciprocating engines, wick feed; thrusts and bearings of exposed deck machinery.

5065—Reciprocating engines and auxiliary machinery, either hand oiled, wick feed, or equipped with drop oilers; heavy machine oil.

5150—For dry saturated steam cylinders of reciprocating engines where condensate is not utilized for boiler feed; swabbing rods; enclosed transmission and differential gears; stuffing boxes of two-cycle double-acting Diesel engines.

5190—For superheated steam cylinder lubrication; swabbing piston rods; transmission and differential gears; additions to tunnel-bearing grease.

6135—Counterflow stationary engines using steam pressures above 90 lb.; stationary engines using wet steam at pressures above 100 lb; steam cylinders of non-condensing engines and pumps; steam shovels, cranes, hoists, cylinders. Not to be used where condensate is to be utilized for boiler feed.

7105—Counterflow steam engines operating on steam pressures below 90 lb.; small portable steam engines used in field service; engines operating intermittently.

8135—Cylinders of small air compressors, except air-injection Diesel engine compressors.

8190—Cylinders of high-pressure air compressors.

9045—Electrical transformers and switches.

As the dealer is forced to meet the demand of the purchaser, if engineers asked for their lubricating oil by symbol instead of by name they would be assured of always receiving the oil they wanted regardless of the manufacturer. If refiners designate the kind of oil they supply by reference to the classifying symbol for the particular oil offered, a greater uniformity in oil deliveries will result. For obvious reasons, it is not suggested that producers give up their trade names, but the brand names should not attempt to indicate the uses to which the oil is to be put.

The adoption of the symbol system by users other than the Navy Department, which now purchases oils by symbol number, would create a demand for greater uniformity in the lubricants supplied with the proportional advantage to be gained by correct and uniform lubrication.

Why the Architect Should Not Design the Power Plant

By Andrew B. Duryee

As a consulting engineer, practicing my profession in the vicinity of New York City, I find the same conditions deplored by other engineers in recent issues of *Power* regarding the architect's designing the power plant, and would like to add to their comments a few first-hand observations.

The architect who makes his contractors do his engineering for him or who accepts free engineering advice from a manufacturer is certainly not giving the owner the service he has the right to expect. The average heating contractor or plumber knows nothing of the design of a heating plant, except possibly a rule-of-thumb method of calculating radiation, which they apply regardless of the type of building construction, exposure and occupancy.

The manufacturer's representive works exactly the same way, except that in addition, he has something to sell, and is prone to figure too much rather than just enough. He will attempt to use his products exclusively on some particular job when a combination would make for better results. It is the manufacturer who should be called to account, for he has been largely responsible for getting the architect into bad habits.

The contractor who is asked to figure on heating work without being furnished with definite plans and specifications, calls in the manufacturer to do the estimating and if the contractor insists, the manufacturer will be furnished with a piping layout, gratis. The majority of men furnishing this service are not technically trained, nor have they had any practical experience, hence judgment, the most important part of any design, is entirely lacking.

As a suggestion, why can we not bring sufficient pressure to bear on the manufacturers so that they all will agree to dispense with the giving of free engineering advice? It seems to me that they should be glad to be relieved of the burden, and in several instances, have so expressed themselves. Why not see that our state-licensing laws are enforced? Other professions are able to enforce theirs, and surely we are as capable as they. We have our great engineering societies to which most manufacturers belong and to which they owe allegiance. Why not put the proposition up to our brother members? As for the architects, is there any good reason why we as engineers cannot select a committee to meet with them and thresh out this problem?

My next suggestion has to do with the ethics of our profession and I realize of course that I am treading on dangerous ground. Why should we as professional men be prevented from telling the people we want to reach, about the service we have to offer them? The average layman ready to start a new project that in all probability requires engineering thinks only of his architect, and will think no further unless somebody tells him. I do not believe that an engineer should open an office and hire a jazz band to draw the crowd, but I do believe that a little dignified advertising would be a great help. This idea of the engineer hiding his light under a bushel—the while he wonders where next month's rent is coming from—does not appeal to me.

Just one more thought, let us all never miss an opportunity to discourage the free and easy use of the term "engineer."

INVESTIGATORS DIFFER AS TO CAUSE OF CROSSETT EXPLOSION

F. G. Straub, of the University of Illinois, finds conclusive evidence of caustic embrittlement; whereas an opinion directly opposite to this is expressed by the Detroit Testing Laboratory. A statement by the Sessions Engineering Company blames inside and outside caulking. An account of this explosion appeared in the July 2 number of POWER.

IN HIS investigation to ascertain whether or not embrittlement was the cause of the explosion Mr. Straub arrived at the following conclusions:

1. The samples of plate submitted for examination had numerous embrittlement cracks.

2. The boiler water was of the same type that has been found in embrittled boilers.

3. The boiler was weakened by embrittlement cracks which undoubtedy caused the explosion.

Mr. Straub continued in his report to describe the nature of the cracking and the character of the water. From data received, it appeared that the rupture had started between the rivet holes of the longitudinal seam. Sections of the main plate and two butt straps were examined. These specimens showed fine cracks radiating out from the rivet holes in a manner characteristic of embrittlement cracking. When the finer cracks were examined under the microscope they were found to be progressing in an intercrystalline manner. The accompanying micrographs illustrate the type of cracks found.

Intercrystalline cracking in boiler plate can be attributed, according to Mr. Straub, to the combined action of stress and chemical attack. Neither one acting alone causes this type of cracking. The only chemical present in boiler water that causes this action is sodium hydroxide. If sufficient sodium sulphate is present, the hydroxide will not attack the stressed metal.

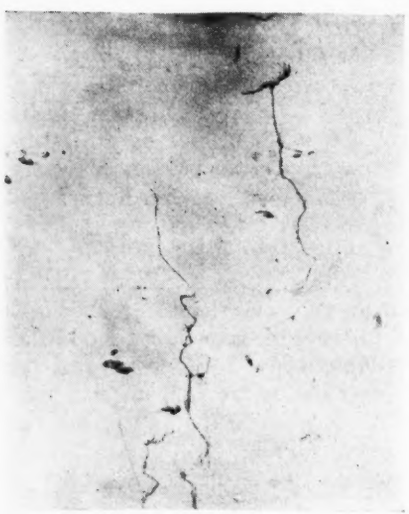
The data furnished showed that the water used was a surface water low in sulphate. The water was treated by the addition of soda ash, causing a total alkalinity in the boiler of about 50 grains per gallon. The alkalinity includes the sodium hydroxide, or caustic alkalinity, and sodium carbonate alkalinity. From the analyses made daily on the boiler water, it had been found that about 75 per cent of the total alkalinity was present as hydrate alkalinity.

The sulphate content of the raw water was so low that if no sulphate were added the ratio of the sodium sulphate to the total alkalinity would be less than 0.3 at all times. This had been found to be so in analyses reported on Aug. 10, 1926, and Jan. 3, 1927. According to recommendations of the A.S.M.E. Boiler Code, the water for these boilers should have had a carbonate-to-sulphate ratio of 1 to 2.

The work conducted at the University of Illinois had shown that a piece of boiler plate stressed in a solution of sodium hydroxide would fail owing to intercrystalline cracking, while a similar specimen stressed in the absence of the caustic solution would not crack. Similar experiments showed that when the sulphate to hydroxide ratio was increased, the cracking could be stopped.

The stresses necessary to allow the caustic attack were in the neighborhood of the yield point of the metal and could readily be accounted for in the form of localized stresses around the rivet holes. When these highly stressed portions came in contact with the concentrated hydroxide that forms in the interstices between the plates and the rivets, embrittlement resulted. The concentration of caustic solution necessary to produce embrittlement was undoubtedly higher than normally encountered in the main body of the boiler. The presence of sodium hydroxide in the boiler water caused seepage to take place in areas that normally would remain tight. The dilute solution from the boiler seeping between the plates slowly concentrated and caused the embrittlement cracking to take place in the highly stressed regions around the rivet holes. Consequently, this in-

Microphotographs illustrating the type of cracks found



Unetched 200 X

Etched 200 X

Etched 1,000 X

stance of cracking was caused by using a water too high in sodium carbonate with a correspondingly low sodium-sulphate content.

* * * *

Finds Transcrystalline Cracks

On the other hand, the Detroit Testing Laboratory, after making an examination of the fractured sections, reports the presence of transcrystalline fractures and expresses the opinion that embrittlement was not the cause of the failure. Its conclusions are as follows:

1. The tensile properties of the shell are satisfactory and indicate that the original material was satisfactory.
2. The bent test further shows that the material was satisfactory.
3. The photomicrographs of the inside and outside of this straight piece show identical structures.
4. The chemical analysis of this steel shows it to be according to usual practice.
5. The tube, as evidenced by the photomicrograph, had not been overheated.
6. The chemical analysis of the fractured piece shows satisfactory steel.
7. The analysis of the deposit on the fracture shows it to be largely sodium carbonate or soda ash. This in itself would not cause embrittlement, as the requirements for embrittlement are sodium hydroxide in the boiler, and on contact with air it is converted over to the carbonate.
8. The several photomicrographs show that the metal at the fracture when strained fractures across the crystals rather than between them. This is a normal fracture and indicates that there was no embrittlement at this point. In the photomicrograph the dark lines extending across the white areas (ferrite) are what is known as "slip bands" or failures across the crystals. In embrittled steels cracks always form in the crystal boundaries without slip bands forming in the crystals themselves.

From this evidence the conclusions are as follows: (1) the original material was satisfactory, (2) the tube was not overheated, and (3) the samples submitted were not embrittled by caustic.

* * * *

Opinion of the Sessions Engineering Company

By R. J. Gaudy
Executive Engineer

The boiler explosion on May 30, 1929, on the west boiler of six identical units at the Crosset Lumber Company's plant has had, and is to receive, so much discussion and interest that the consulting engineers who originally installed the plant feel that in justice to the situation they should release a statement at this time.

The conditions, which do not allow immediately discharging this case as a typical failure to be classified with previous failures, are as follows:

1. There is no sign that these boilers were ever operated under conditions to produce distress.
2. The boilers were all built with the safety factor of five.
3. The concentration of the boiler water was taken consistently and periodically, and during the three years preceding the failure the total alkalinity in water samples from the boiler varied from 35 to 45 grains per gallon.
4. These boilers were practically free from scale.
5. The seams were inside caulked.
6. The condition of the steel in all parts of the boiler, other than the localized area at the point of failure, showed a proper structure and treatment, and a properly sustained quality after six years of operation.

All of these conditions might well be assumed to exist on hundreds of boilers on which there is no thought of possible approach to failure.

It should be remembered that at the time these boilers were installed, there was no agreed technique as to the caulking of boilers as referred to crevice concentration.

The excess stress on the edge of the drum plate, which is inherent in the operations necessary to the manufacture of drums, and the excess localized stress due to the butt-strap riveting shows no difficulty on boilers that were not involved in localized failure.

Neither the periodic insurance inspection, nor the later inspection of the complete boiler interior on other units, identically operated and on the same header and carrying similar concentration, showed evidence of corrosion on the exposed areas.

In the opinion of the engineers, the crux of the situation lies in the fact that the butt-strap joints were caulked both inside and out, and that the drum being an assembly which was repeatedly passed through expansion and contraction changes, due to change in temperature, and which doubtless was rocked back and forth by the adhesion of the forward face of the drum to the slag formed on the bridge wall, brought about in certain locations an opening-up of the inside caulking. Since the boilers were caulked both inside and out, an opening-up of the outside caulking would show no evidence of leakage, due to the fact that the inside caulking would hold. If both caulkings cracked, then the leakage would call attention to the localized condition, and the repair could be made by recaulking.

The conjecture published discussing the water load distortion is discharged by the fact that every multiple drum boiler is identical in this respect.

When, as apparently was the case, the inside caulking did open up and allow the infiltration of boiler water, the accumulated alkalinity continued. This is evidenced by the presence of deposits in the crevices that remain.

The hydrogen corrosion takes place when the available corrosive medium is of sufficient concentration and produces faults in stressed metal by progressive fulcrum action in the root of each microscopic crack, as it tends to open and close, spreading this crack deeper and deeper as corrosion continues, each successive spreading opening new clean metal to the attack of the corroding element.

We believe that the presence of the outside caulking made possible the continuation of this action, where it might have been detected had this caulking not been present.

This, however, does not give any solution of the cause, nor suggest a remedy to prevent localized conditions which could produce crevice cracks.

The use of welded drums would have eliminated the case of trouble described herein.

The case is singular in that there is no faulty construction nor operation evident, and the conditions in the boiler are not such as would be identified as contributing to such a failure, nor has inspection evidenced the approach of such failure. The disastrous failure, however, did occur, and the rather complete data are certainly at the disposal of those who are interested.

Right Out of the Plant

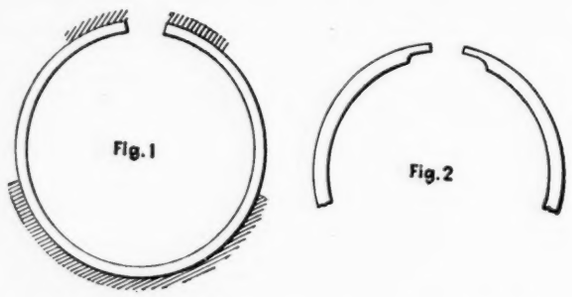
Notes on Building Internal-Combustion Engines

IN THE Feb. 12 number of *Power* (page 281), in an article entitled "Notes on Building Internal-Combustion Engines," the following paragraph appears:

> The piston rings of these engines are not finished to a glaze, but left somewhat rough, much like the cutting edge of an extremely fine hacksaw. During the trial on the test floor these projections wear rapidly to the contour of the cylinder liner, thus insuring a gas-tight joint.

To me this seems to be bad practice, because the gap in the ring increases about three times as fast as the diametral wear that is taking place. The ring gap will thus be too wide, and the high pressure gases will blow through the gaps and offset the advantage of quickly bedded rings. When, as is the common practice, the outside surfaces of the piston rings are finished by grinding, the gap is kept within specified limits.

It is usually found after test that the rings are not bedded in correctly, and may have heavy bearings at the shaded portions shown in Fig. 1. The heavy bearings near the gap can be removed to a considerable extent by



How the pressure is relieved at the ring joint

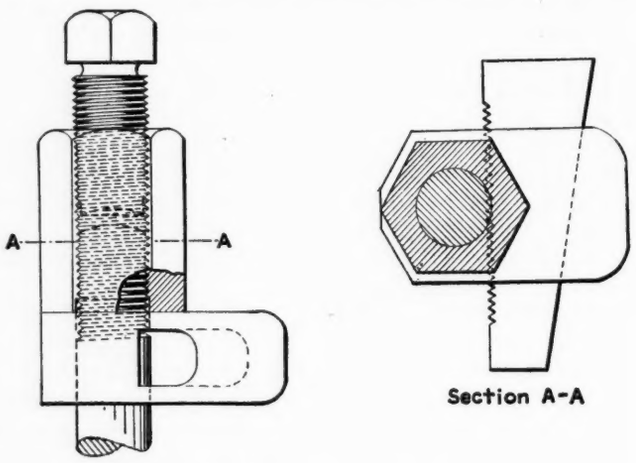
relieving the inside face of the rings, as shown in Fig. 2. This will tend to spread the bearing around the circumference of the rings, and a gas-tight joint will be obtained more quickly.

DOUGLAS P. MUIRHEAD.
Glasgow, Scotland.

A Practical Stud Extractor

THE withdrawal of studs when they are in awkward places sometimes presents difficulties that could easily be overcome if a tool suitable for the purpose were at hand. While most of the older workshops have these special tools, the general run of shops depend upon the use either of a stillson wrench or upon the use of two nuts and a washer jambed on the stud to be withdrawn. These makeshifts prove effective in the hands of a good workman, but usually result in damage to the stud.

The device illustrated has proved satisfactory for this work. A piece of hexagonal tool steel, two or three nut-sizes larger than the stud for which it is to be used, has an extension block forged on one end to take the wedge as shown. A tapping hole is drilled through it along the long axis. This tapping hole is counter bored from the base end to a sufficient depth to allow the blank part of the stud to enter far enough for the teeth of the wedge to engage with it. The rest of the hole is tapped to the size of the stud for which it is intended.



Details of stud extractor

A regular open-end wrench to fit the hexagon completes the outfit. By screwing a cup-pointed, hardened steel setscrew into the top end the extractor can also be used to set studs.

F. P. MACNEIL,
New York City.

The Loeffler Process and the Benson Boiler

IN the June 4 number of *Power*, H. W. Queisser, junior test engineer of Siemens Schuckert, Berlin, published a reply to my articles of March 19 and 26 in which he discussed the advantages of the Benson boiler.

Mr. Queisser seems to consider as the chief advantage the use of high pressures of 3,200 lb. and more, which the Benson boiler is forced to employ. The Loeffler system uses mainly pressures from 1,900 to 2,200 lb., but with very high temperatures—up to 950 deg. F. This does not mean that the Loeffler system could not operate at higher pressures with advantage, but all the calculation and comparisons have proved that these pressures bring the greatest economic advantages. With the Loeffler boiler, also, pressures up to the critical state can be controlled safely, and even with the advantage that the work of the pump necessary for the circulation of the steam *decreases* with increasing pressure. However, at pressures over 2,200 lb. the expected heat gain is eaten up by the considerably increasing investment costs, so that pressures higher than 2,200 lb. do not bring a profit.

The Benson boiler is forced to work with a pressure of 3,200 lb. and is forced to throttle this pressure down to the working pressure. Therefore, it is compelled unnecessarily to pay higher investment costs.

The most important thing is *high superheat*, which is controlled in an absolutely safe way by the Loeffler

system, employing steam temperatures of 930 deg. and more. The safety of control is connected with the forced circulation of steam through the superheater and the simple and dependable regulation of the superheat by means of the pump. Even when the load of the plant fluctuates very strongly, the superheat can be kept constant by the effect of the pump. With ordinary boilers and with the Benson boiler occasional severe fluctuations of superheat cannot be avoided. These fluctuations can amount to 200 deg. F. and more, so that in spite of the better heat transfer of high-pressure steam, higher steam temperatures than 840 deg. may not be carried without danger of burning the tubes.

Mr. Queisser thinks that with the Benson boiler the heat transfer is better than with the Loeffler boiler. Besides this he believes that scale is deposited in the economizer of the Loeffler boiler. The important fact, however, is not whether the heat transfer is somewhat better or worse, because this can be regulated by the speed of the flow. It *is* important that with the Loeffler boiler only pure steam is heated where the highest gas temperatures exist, whereas, with the Benson boiler water is evaporated, and boiler scale and impurities can settle on the tube walls, so that the heat transfer is considerably hindered. Even assuming that fixed boiler scale should settle down in the water preheater of the Loeffler boiler, no dangerous consequences would occur, because the preheater is heated only by gases of lower temperature (from approximately 930 to 1,300 deg. F.).

In reality no scale whatever forms; sediment and impurities are brought to the evaporator drum, where they settle down in form of slime, which is easily drawn off during operation.

If, for example, on ships, the water occasionally contains many impurities, it is a simple matter with the Loeffler system to omit the water preheater (economizer) heated by flue gases and to preheat the water only by bled steam to about 390 deg. When the air is preheated to from about 750 deg. to 930 deg. instead of from 212 deg. to 570 deg., as usual, then the same efficiency is obtained as with boilers with a gas-heated economizer. Such a design is not possible for the Benson boiler, which is always forced to heat water.

Mr. Queisser is in error if he believes the work of the steam circulating pump and feed pump for the Loeffler boiler with 1,850 lb. pressure and 930 deg. superheat temperature to be larger than the work of the Benson feed pump. It is obvious that the work done by the Loeffler steam pump is transmitted to the steam, so that no heat losses exist. In spite of this, one must take care that the work of the feed pump as well as that of the steam pump remain as small as possible, because this work is regained with the efficiency of the whole plant only.

Even assuming the pressure which is to be overcome by the Benson feed pump to be only 3,200 lb., a simple calculation shows that the work of the feed pump is larger than the combined work of the steam circulating pump and the feed pump of the Loeffler boiler. In this connection it is to be noted that at 1,850 lb. and 930 deg. 2.7 tons of steam must be pumped for every ton of steam generated with the Loeffler boiler, and that the back pressure for normal load of the boiler is only from 43 to 57 lb. With the Loeffler boiler, however, it is necessary only to operate one feed pump for the steam production, because, on account of the water content of the evaporator drum and the indirect steam production, no danger exists even when stopping the feed pump. With the Benson boiler a stopping of the feed pump would eventually cause the tube to burn through because of their small water content. Therefore, it is necessary for the practical operation of Benson boilers always to have two pumps in operation. This must result in a great reduction of efficiency when using centrifugal pumps.

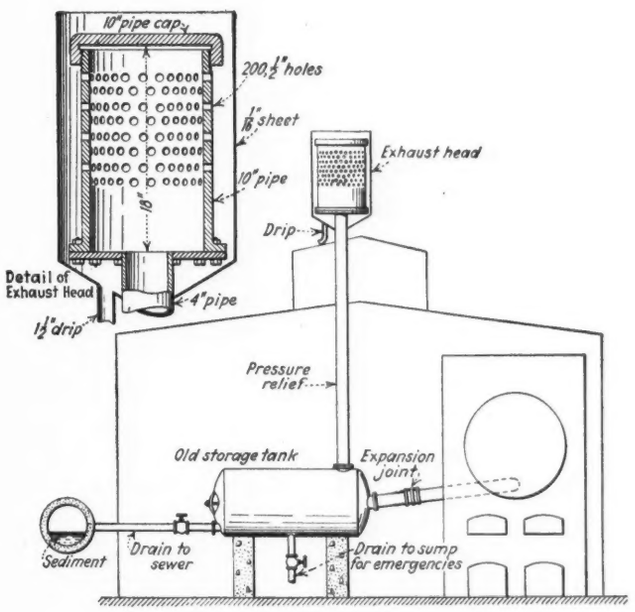
The Benson boiler must be more costly than the Loeffler boiler, because steam or water accumulators are necessary to balance fluctuations of the load. The boiler also uses a complicated and sensitive automatic regulation, which is not only expensive but needs careful attention.

Nevertheless the possibilities for the use of high-pressure steam are so varied that there is enough place for both the Benson and the Loeffler boilers. The future will prove which system has greater advantages.

DR. ST. LOEFFLER,
Professor, Technische Hochschule.
Charlottenburg, Germany.

How a Blowdown Problem Was Solved

OUR power plant is located close to a number of residences and when first put into operation the blowdown was connected direct to the sewer. This plan worked well for a while, but the sewer began to fill up with sediment and the steam discharge from the sewer became objectionable. The trouble was overcome



Exhaust head applied to blowdown tank to lessen noise

by rigging up the blowdown tank as illustrated. The entire installation was made from parts and material that had been used previously and were found on the scrap pile.

An important feature of the arrangement is the exhaust head, which was designed to reduce the noise, at the time of blowdown, as much as possible. It proved to be satisfactory, as only a moderate hissing sound can be heard, which is not at all objectionable.

Mercersburg, Pa. JOSEPH H. FUNK,
Supt. of Bldgs. and Grounds,
The Mercersburg Academy.

Mineral Oil and Graphite Lubricates Press Fits

THE article by N. L. Rea on "Mineral Oil and Graphite Lubricates Press Fits," in the May 14 number, brings to mind the uses to which lard oil was put many years ago in shops and on ships.

Lard oil was used as a "cutting oil" when threading bolts and screws with a threading machine, or with hand stocks and dies, and for tapping nuts or making holes in wrought iron and steel, not because it was the only oil available, but because it was at that time the only oil that would produce a clean and smooth thread.

Lard oil was also used in hand lamps, because it would burn with a clear white flame, without smoke and without any disagreeable odor. At the time it seemed to be the only oil obtainable that was suitable for open-flame lamps.

Another purpose that called for the use of lard oil in machine shops was that of mixing a quantity with red lead or Prussian blue, for "marking" or "spotting" bearings or other surfaces to indicate high spots. Here again, no other oil would suit this purpose quite so well as lard oil; in fact, machine oil would not do at all.

Brooklyn, N. Y. CHARLES J. MASON.

Design of Superheaters

THE PAPER on "Design of Superheaters," by R. M. Gates and C. W. Gordon, in the May 28 number, discusses the coefficent of heat transfer between the inside wall of the tube and the contained steam, and its influence upon the temperature-characteristic of a superheater. I should like to discuss these two points from another angle:

The coefficient of heat transfer between the tube and the steam increases with the 0.8 power of the velocity of steam and finally becomes so great—and, consequently, its reciprocal value, namely, the resistance of heat transfer, so small—that it may be neglected in comparison with the resistance on the outside and in the tube wall. Not the heat transfer coefficient, but the heat transfer, increases up to a "critical point," and this "critical point" then depends only on the coefficient of heat transfer between the gas and the metal wall, the conduction in the tube wall, and the mean temperature difference between gas and steam.

Within the entire range from about half load to maximum load the resistance of heat transfer between the metal wall and the steam is so small that it has no appreciable influence on the temperature characteristic of the superheater.

The reason for the drop of superheat at maximum load lies almost exclusively outside—for the following reason:

If the load of a boiler increases, for instance, from three-quarters to normal load the gas temperature in the superheater increases. This means that a greater mean temperature difference between gas and steam is available. This, however, is counteracted by (1) the fact that the heat transfer between gas and metal increases with a power of the quantity of gas which is smaller than 1, that is, if the mean gas temperature in the superheater remained the same and if merely the quantity of gas and steam changed proportionally, the superheat would have to drop off; (2) the moisture of the steam at the superheater inlet, which rises with the load; and (3) an increase in the steam temperature, which reduces the mean temperature difference.

Calculation and experience show that the first-named influence of the higher gas temperature predominates at low loads, so that the superheat increases with the load. This increase does not take place in a linear proportion with the load; it takes place more slowly. The steam temperature, increasing with the load, tends to attain a definite maximum value. If, as an example, the load is raised to such an extent that the influences opposing one another are equalized (the height of the gas temperature is limited by the heat value of the fuel), the steam temperature at the outlet of the superheater will not be increased further.

At this critical point the influence of the heat transfer coefficient, increasing more slowly than the load, begins to preponderate on the gas side, and the steam temperature drops off, to become, finally, at an infinitely high load, again equal to the saturation temperature.

It follows, in any case, that the part of the characteristic of a convection-type superheater, coming into practical consideration, shows a temperature course given in Fig. 6 of the article previously referred to.

The shape of this characteristic is, in an individual case, substantially dependent on the location of the superheater within the water tube heating surface, and in such a manner that the superheat fluctuations increase with a greater heating surface before the superheater.

An advantage of the multiple-loop, single-pass design of superheater with junction box is that if in the low-temperature section a tube should supply excessively superheated steam, this superheat is reduced again in the junction box by mixture with the steam from the adjacent tubes, so that no danger arises for the high-temperature section. F. MICHEL.

Berlin, Germany.

Improvised Pump for Air Chamber

THE method of replenishing the air in the air chambers of feed pumps which was described in the July 9 number of *Power* seems to me to be suitable for hot water or fluids which might attack the rubber valve disks of the pump. For water pumps using comparatively cool water, however, a much simpler device can be used.

To one or both ends of the feed pump cylinder is attached an ordinary tire valve. These valves, of course, close under pressure, but open under suction. Hence, on the suction stroke, a small amount of air will be drawn into the cylinders and discharged to the air chamber on the pressure stroke.

Most automatic pumping systems such as used in isolated installations use this method. On small pumps a single valve would be sufficient, so the cost of installation and upkeep is negligible. L. G. JONES.

Pittsburgh, Pa.

NOT AIR FLOW BUT GAS FLOW—It is time that the old misnomer, "air flow," used in connection with differential draft in the gas passages of boiler furnaces be discontinued and that the correct name, "gas flow" take its place.—Lewis M. Ellison, Chicago.

What's New in Plant Equipment

HOW THE MANUFACTURER CONTRIBUTES TO THE JOB OF GENERATING TRANSMITTING AND APPLYING THE POWER SERVICES

Electromagnetic Chemical Proportioner for Water Softener

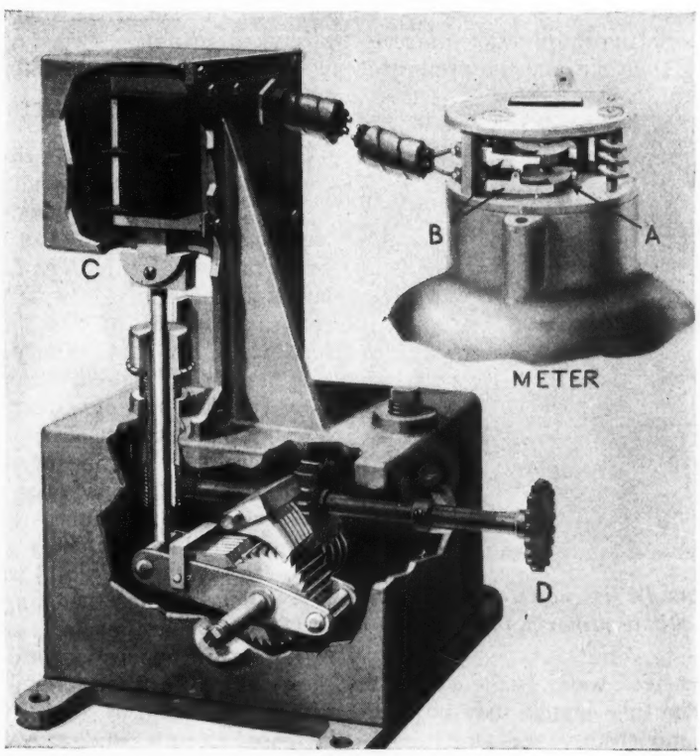
AS THE basic unit of all the lime and soda softeners made by the company, whether using the hot, semi-hot, or cold process, the Paige-Jones Chemical Company Inc., of Hammond, Ind., has developed the electromagnetic proportioner shown in the accompanying illustration. The proportioner is mounted on top of the chemical tank, and amount of water supplied to the softener controls the volume of chemicals introduced, so that a fixed ratio is maintained and therefore a known reaction obtained. Regardless of the amount of water required during a given period, each gallon of water passing through the softener will receive the proper amount of chemicals necessary to render that water free from scale-forming impurities.

An outstanding feature is the fact that all the water fed to the softener is measured by the standard water meter shown at the upper right of the illustration. On one of the metering shafts are two fiber cams *A* shaped like ratchet wheels with coarse teeth. Bearing on these cams are two spring contacts *B* used to open and close an electrical circuit. The cams are identical but are staggered in relation to each other on the shaft, so that when the end of the upper contact-spring reaches the sharp depression in the cam, it will drop abruptly and make contact with the lower spring, closing the circuit until the lower spring reaches the depression in its cam, when the circuit is abruptly broken. This mechanism gives a predetermined number of quick makes and quick breaks in the circuit and it will be seen that there is a known relation between the number of impulses in the circuit and the amount of water measured by the meter.

To translate these impulses into mechanical motion that will regulate the chemical feed, the electromagnetic unit *C* at the left, consisting of a solenoid at the top, with an armature connection to a ratchet and gear train, is used. Each time the circuit is completed the solenoid in the upper housing is energized, causing the armature to be drawn up through the coil and pulling with it the armature extension, connected to a rocker arm with a series of pawls that engage a ratchet wheel. In this way the rotation of the ratchet wheel is made to maintain a fixed relation to the amount of raw water fed to the softener.

Through a worm and gear the movement of the ratchet actuates a sprocket located outside of the case. A chain running over this sprocket is attached at one end to a counterweight and at the other to a swivel take-off pipe in the chemical tank. Thus the chemicals are fed by being skimmed off the top of the surface in the chemical tank as the take-off pipe is lowered by the turning of the sprocket. Every time an electrical contact is made at the meter, the solenoid and ratchet function, giving a proportionate turn to the sprocket, so that the take-off pipe is lowered by degrees and always maintained at the top level of the chemical charge until it is exhausted (in 6 to 24 hours, depending upon conditions). The swivel take-off pipe leads to the suction of the pump which forces the chemicals into the top of the softener. When the charge has been depleted, the take-off is raised by hand to the top position, the tank filled with chemical and the same cycle of operations repeated. On the extension to the armature shaft a vernier regulates the stroke and thereby the movement of the ratchet wheel. In this way accurate adjustment can be made of the amount of chemicals required for the treatment of any given water. The solenoid is located in a sealed bronze box and all the working parts of the proportioner are encased in an oil-tight bronze housing filled with oil. Outstanding advantages of the unit are its small size, and its location on top of the chemical tank, which permits floor-level operation regardless of the size or type of the softener. Where a number of chemicals are to be fed separately, the same number of these proportioner units can be operated from one set of contacts on the water meter.

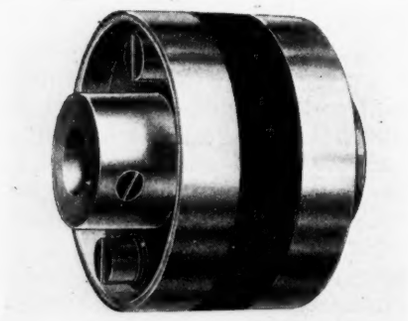
Cut-away view of proportioner with connection to meter



Light-Duty Flexible Coupling

A SMALL light-duty flexible coupling, designated Type C, has been added to the line put out by the Ajax Coupling Company, Westfield, N. Y.

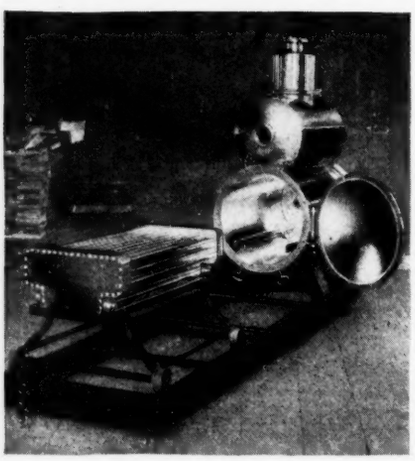
The coupling consists of two die-cast flanges of equal diameter, with a rubber centerpiece or a flexing element. Connection of the two flanges is made by four screws, which are screwed through the flanges and into nuts molded permanently into the centerpiece. The coupling is made with shaft bores ranging up to 1¼ in. in diameter.



Type C flexible coupling

Removable Tube Bundle Evaporator for Scale-Forming Solutions

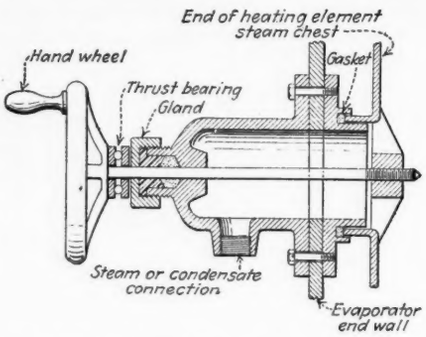
AN IMPORTANT feature of the evaporator developed by G. A. Zeitler for the evaporation of scale-forming solutions and the production of boiler feed water is the ease with which the tube bundle may be withdrawn and cleaned.



Tube bundle is mounted on rollers to facilitate removal for cleaning

The evaporator consists of four principal parts, a removable tube body, evaporator body or boiling chamber, a vapor chamber placed above the evaporator body and a catch-all at the top of the vapor chamber. The tube bundle is mounted on rollers on which it may be run from tracks within the evaporator body to a carriage on a track in front of the evaporator. The section shows how the tube bundle is attached to the steam and condensate connections in the rear head of the evaporator.

The vapor chamber is slightly smaller in diameter than the evaporator chamber and connects with it for its entire length. The catch-all, placed on top of the vapor chamber, is merely a dome to which the vapor line to the condenser is connected. The machine is available in various sizes and in metals for any type of service. It is being manufactured by the Oakland Copper & Brass Works, Oakland, Calif.



Method of making steam and condensate connections in rear head

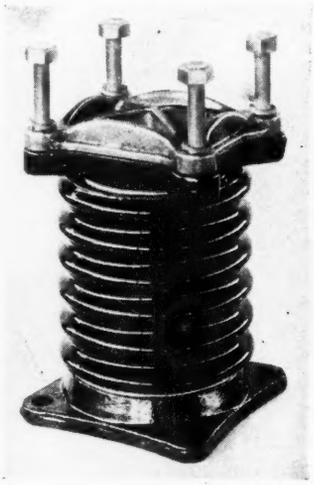
New Facing Metal for Grinding Parts

TWO new alloys, designated Cristite Series 1 and Cristite Series 3, have been introduced by the Commercial Alloys Corporation, San Francisco, Calif. The first alloy has a hardness of 61 to 67 and the second a hardness of 49 to 55 on the Rockwell C scale. Ordinary welding equipment can be used to apply both alloys as a surfacing. They simply flow on to the surface to be protected. They are supplied in the form of welding rods. Either may be used for surfacing the hammers of crushing and grinding equipment, although the Series 3 alloy is said to withstand impact much better than Series 1.

The alloys are made from magnetite and in application, are said to show a good penetration into the metal surface and to result in greatly increased life of grinding equipment.

Heavy-Duty Bus Support for Indoor Service

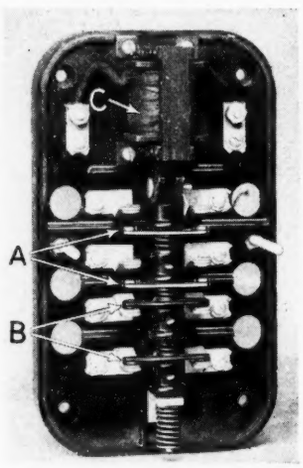
A NEW and improved line of heavy-duty bus supports for indoor service up to and including 25 kv. is announced by the Champion Switch Company, Kenora, W. Va. The porcelain units are furnished in diameters of 4 in., 5 in. and 6¼ in.



Improved heavy-duty bus support

Multi-Finger Relay

THE new multi-finger relay illustrated has been designed for the remote control of a number of independent alternating current circuits. It consists of a series of double-break, silver-faced fingers (*A* and *B*) operated horizontally and controlled by a small solenoid. The power consumption of the solenoid is eight watts. Creepage and clearance for 550 volts have been provided, and the contacts will carry fifteen amperes continuously. The relay is manufactured by the General Electric Company, Schenectady, N. Y.



Relay with cover removed

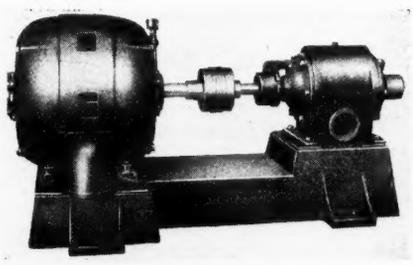
Air-Set Cement and Baffle Mix

RECENT additions to the line of refractory materials put out by the Babcock & Wilcox Company, 85 Liberty St., New York, include the No. 80 air-set cement and No. 80 baffle mix. The air-set cement is suitable for bonding fire bricks in thin walls, door linings and for similar applications, as it will set hard without the employment of heat and will bond at all temperature. It can be used up to within 50 deg. of its melting point 2,875 degrees.

The baffle mix is suitable for use in making poured or molded boiler baffles and for lining explosion doors or cleaning doors not subjected to the temperatures encountered in the furnace proper. It sets without application of heat and retains its hardness up to temperature of 2,700 deg.

Oil Mill Eliminates Sludge in Storage Tank

THE PROCESS of sedimentation which takes place when oil is allowed to stand in a storage tank results in an accumulation of sludge and heavy oil particles at the bottom of the tank. This sludge invariably gives trouble by clogging burners if pumped through the system without



Motor-driven oil mill

being thoroughly stirred or mixed with the lighter oil in the tank.

To obviate the necessity of cleaning the accumulation from the bottom of the tank which requires considerable labor and represents a loss of fuel, the Volcanic Specialties Company, Alliance, Ohio, has developed the oil mill illustrated. The mill is connected in the oil line between the pump and the burners and is designed to mix the sludge thoroughly with the oil on its way to the burners. In this way, by simply stirring up the sludge in the tank so that it will pass to the pump, it is possible to use all of the oil, as well as keep the tanks clean, without periodic draining and cleaning out, as is the usual practice.

The mill is direct connected to a ball-bearing motor through a flexible coupling, and the complete unit is mounted on a common base. The size of the oil-line connection to the mill is two inches.

Three instruments fit in one case

Set of Portable Meters in Carrying Case

SETS of three portable direct current instruments for general testing purposes may now be obtained in a leather carrying case but $6\frac{1}{2}$ in. wide, $8\frac{3}{4}$ in. long, and $7\frac{1}{4}$ in. deep. The instruments, which occupy separate compartments in the carrying case, are enclosed in molded micarta, and each instrument is $4\frac{1}{2}$x$4\frac{1}{2}$x2 in. in size.

The instruments are of the D'Arsonval type and are designed for the usual purposes of medium sized, light weight instruments. Type PX-4 is the designation given the instruments by the manufacturer, the Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa.

Feed-Water Treatment in Brick Forms

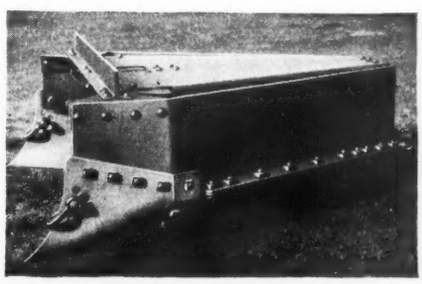
A FEED-WATER treatment known as Selco "Power" has been introduced recently by the Standard Engineering & Lubricating Company, 120 West 42nd St., New York City.

The treatment is put up in brick form, each brick weighing approximately $\frac{1}{2}$ lb. Among the claims made for the treatment by the manufacturer are that in addition to dissolving the scale now present it will prevent corrosion, pitting and foaming and will not injure packing or gaskets.

Power Plow Scraper for Handling Coal

ESSENTIALLY a right- and left-hand plow joined in the rear and having a vertically adjustable cover plate that stops overdigging and can be adjusted to increase or decrease the normal capacity, the power plow scraper made by the Garst Manufacturing Company, 549 West Randolph St., Chicago, is to be applied to the handling of coal. It is made in sizes ranging from $\frac{1}{2}$ to 6 cu.yd., and can be furnished in larger capacities. In capacities up to $1\frac{1}{2}$ cu.yd. the construction is as indicated in the accompanying illustration. For larger sizes the scrapers are of heavier construction, with a double reinforced cutting edge, a double I-beam supporting the top of the front end, and digging noses of special alloy steel.

While digging, the plowshare nose and cutting edge are below the surface, the cutting edge being set at an angle of 26 deg. to the line of pull. The cover causes the scraper to dig until it is fully loaded, when it rises to the surface and slides over the material being handled. Adjustable up and down from the top of the side walls, the cover plate gives a 50 per cent variation in the load of the scraper, permitting it to meet various



Plow of one and one-half cubic yards capacity

conditions, such as changes in the power of the hoist and materials of different weight and density. When working under water the cover prevents the load from washing out. The scraper dumps at any point by moving it backward.

Owing to the digging nose, the adjustable top and the shearing cutting edge, minimum pull, and therefore minimum use of power, is a claim for this scraper. Another important feature is the fact that the plow points and the bottom wearing surfaces are renewable. Different designs of plow points can be substituted to meet varying conditions.

FROM AMONG READERS' PROBLEMS

CONDUCTED by L. H. MORRISON

TOTAL HEAT OF STEAM—*In an engineering meeting one member claimed that the steam tables were wrong, for, so he said, "the amount of heat called 'total heat' in the table, is not the heat in a pound of steam." Is he correct?* P. A. Y.

Yes, the "total heat" column in steam tables gives the heat added to bring a pound of the fluid from 32 deg. to the stated condition. But in changing its volume, the steam must do work on its surroundings to make room for itself. For example, when evaporating at, say, 100 lb. the steam expands and forces the steam in the main along toward the engine cylinder, and this latter steam in turn forces the piston along the stroke until cut off occurs. The steam evaporating in the boiler then does work on the engine piston, and this work uses up part of the heat needed to evaporate the fluid. The steam, then, does not contain all the heat actually added to it, and only contains the heat equivalent of its internal energy, which is given in another column in the steam tables. Conversely, if the steam were condensing, the piston of the engine would exercise a force on it to cause the volume to decrease; this would return to the steam an amount of heat equal to the heat expanded on the piston when the steam was evaporating. You can get out of the steam all the heat added to it, but this total heat is never entirely contained in the steam.

FLOW OF AMMONIA THROUGH AN ORIFICE—*Is it possible to measure the amount of liquid ammonia flowing through an orifice?* C. A. R.

One formula, which Prof. E. F. Miller advanced, is

$$W = \frac{0.4\ A.\ P.}{\sqrt{T}}$$

where W = pounds of ammonia per sec.
A = area of orifice in sq.in.
P = initial ammonia pressure, lbs. per sq.in. abs.
T = initial temperature of ammonia, deg. F. abs.

This holds for an orifice of a length of twice its diameter and with a rounded edge having a radius of one-half the orifice diameter.

WHY EXCESS AIR IN FURNACE—*If excess air actually increases the heat passing out with the fuel gases, why have any?* R. M.

If furnace linings could understand the heat of combustion, it would be highly desirable to reduce the excess air to a point where there were no significant loss from CO. But a minimum of about 25 per cent is as low as one can go with coal without a loss due to imperfect combustion.

SETTING DUPLEX PUMP STEAM VALVES—*How should one go about setting the valves of a duplex steam pump?* A. C. B.

First set both rocker arms so that they are vertical, which indicates that the two steam pistons are in the mid-stroke positions. Next remove the steam-chest cover and adjust the valve stem lengths until the valves are in the center position, covering all steam ports. Now adjust the valve nuts to give equal play on each side, which will give equal dwell of the pistons at the ends of the stroke.

COMBUSTION IN A DIESEL—*I have always thought that the Diesel engine burned the fuel so that the pressure line during the injection period was horizontal, denoting constant pressure. With our 500-hp. Diesel the indicator diagram shows a sloping combustion line. What is wrong?* E. J. S.

While originally it was believed that there should be a fairly horizontal combustion line, denoting constant pressure and all the Diesels gave such an indicator diagram, it is not the present practice in Diesel engine design to have a flat combustion line; a more peaked line is usual. A sharp combustion line gives a greater thermal efficiency; furthermore, even with a flat combustion line for some 10 per cent of the stroke, the actual combustion of the fuel continues well along the stroke, as much as $\frac{5}{8}$ stroke in many engines.

You should not attempt to alter the cam nose to give a constant pressure line.

MEANING OF AN ATMOSPHERE OF PRESSURE—*Is the pounds per square inch equivalent of one atmosphere always the same?* C. C. M.

There are two values for an atmosphere of pressure. The metric atmosphere, used in Germany and other European countries, is based on a pressure of one kilogram per square centimeter, which when transferred to English equivalents is equal to 14.22 lb. per square inch.

The value of the atmosphere as used in America is 14.7 lb. per sq.in.

PREVIOUS QUESTION

DISCUSSED BY READERS

THE QUESTION

FOR non-condensing operation, with 200 lb. gage, 100 deg. F. superheat at the throttle, should a 500-kw. unit be a turbine or a reciprocating engine? C. R.

IN CONNECTION with the question no statement is made concerning the use to which the exhaust steam is to be put. The amount of exhaust steam required for manufacturing or other purposes would naturally be a factor for consideration.

If steam economy is a desirable factor, and it usually is, I would select a uniflow engine as the most suitable unit in a 500-kw. set. If, due to heavy demand for exhaust, steam economy is of minor importance and initial cost is all important, then I would choose the turbine. However, regardless of present-day conditions, in the purchase and installation of a unit of this size, a careful study of what might be most suitable in the future should be made.

A uniflow engine of the capacity referred to operating either condensing or non-condensing would be more economical than a turbine in this size unit. The guaranteed water rate of a uniflow engine operating non-condensing would be 18.5 to 19.5 pounds per horsepower-hour, with but a slight difference in efficiency from quarter load to full load. The engine, if given the attention it deserves, will not change materially in efficiency over a period of several years, whereas a turbine will gradually become less efficient until re-blading becomes necessary.

While the initial cost of an engine would be almost twice the cost of a turbine, several other factors are in favor of the engine. Less trouble will be experienced with the engine, resulting in more reliable operation and consequent economy from uninterrupted service. I would suggest a low-speed specification, which would result in a higher first cost but would insure more satisfactory service in a general way. I consider the noise in the engine room a factor worthy of consideration, and an engine of this type when properly cared for should be almost noiseless in its operation.

The water rate of a steam turbine in this size operating non-condensing would be around 25 to 26 pounds per horsepower-hour. As the destructive, erosive and corrosive elements tend to gradually decrease the efficiency of a

turbine, a general overhauling of the unit will be necessary when the condition becomes bad. The cost of reconditioning the unit should be a factor for serious consideration, and possibly added to the initial cost, or else a much higher depreciation cost must be written off. If it is necessary to shut down a part of the plant during this overhauling period, then other factors enter. As in either case there would be a saving of approximately 1 per cent for each 10 degrees superheat added, I would suggest that unless superheaters are already installed the superheat specification be raised to around 200 deg. F., which would give a total temperature of 580 deg. F. This would result in longer life for the turbine blades due to the use of dryer steam. The superheat will not be at a constant value at the best, but it must be remembered that excessive superheat is destructive in some respects, in particular where cast iron is encountered. Excessive superheat may cause crystallization or cracks in cast-iron fittings or parts; also cylinder lubrication becomes more difficult.

A compound engine would be about the same as a turbine in steam consumption, but due to the higher price I would hardly consider the situation from this angle. However, if the unit is to operate continuously against a back pressure, more satisfactory results would be obtained with such a unit.

The electrical equipment is another angle for consideration which might alter the entire problem.

E. E. MERRILL,
Plant engineer, Kelly Press Division
American Type Founders Co.
Elizabeth, N. J.

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IN SELECTING a prime mover for power purposes there are many items to consider before rendering a decision as to whether a turbine or reciprocating unit should be employed.

The more prominent considerations to analyze before making the final decision are: First cost of prime movers, value of floor space that prime mover is to occupy, cost of suitable foundation, piping, and installation of the machine, value and utilization of steam in the respective plant, with regard to the industry which the prime mover is to serve, and the cost of maintenance and attendance.

An engine having a rated horsepower of 750 would be needed to carry the load. Manufacturers will safely guarantee a 17-lb. per indicated-horsepower-hour water rate at 200-lb. pressure and 100 deg. superheat, for compound four-valve Corliss or poppet valve or for uniflow engines exhausting against atmospheric pressure.

Turbine manufacturers will safely guarantee a 28-lb. per kilowatt-hour water rate. Thus, the steam consumption in the case of the reciprocating engine would be, roughly, $725 \times 17 =$ 12,325 lb. per hour, and that of the turbine 500×28 lb. $=$ 14,000 lb. per hour.

The reciprocating engine for non-condensing service and full load would have a lower steam consumption than the turbine.

If all the exhaust steam could be utilized in processes, the electric power would be a byproduct, and the difference in steam consumption between the two would be of no consequence.

The turbine has the following advantages over reciprocating steam engines: Lower first cost, lower maintenance and attendance costs, less floor space and cheaper foundation and construction costs, no lubricating oil in exhaust steam, less vibration than a reciprocating engine, uniform steam flow and closer regulation of speed and greater reliability of service at the higher steam temperatures.

Summing up, therefore, we may say that where the exhaust steam is utilized, the turbine would prove the more economical choice; and the reciprocating steam engine would prove the more economical in a case where the exhaust steam is not utilized in the process of the industry in which the prime mover is to serve.

ED BAERER.
Bayonne, N. J.

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I WOULD favor a turbine under the conditions stated, for the exhaust steam, being free of oil, could be used in process work or in heating.

The high temperature of the steam, 488 deg. F., would make lubrication of the reciprocating unit a doubtful proposition. The turbine would occupy less floor space and the foundation would be a simple affair.

The water rate would average the same for both machines, but at light and heavy loads the turbine would be more economical.

The turbine would be practically self-contained, and the care of it would be reduced to a negligible amount of supervision.

JOSEPH O'BRIEN.
Rosedale, L. I.

A Question For Our Readers

WE ARE operating a number of synchronous motors on a system with an induction-motor load. There has been considerable discussion in our operating department as to what value of power factor the synchronous motor field current should be adjusted, to obtain the most economical operation.

P. W. P.

Suitable answers from readers (of not over 200 words) will be paid for and published in the Sept. 3 issue.

THE question is not one of thermodynamics. With non-condensing operation the over-all thermal efficiency of the two types of equipment is about the same. While it is true that the turbine makes better use of the additional heat available due to superheat, yet, on the other hand, the lessening of initial cylinder condensation in the engine will about equal the turbine's gain. It is assumed that a compounded engine is used for this size of unit.

The points to be considered in choosing between the two types are economic rather than thermal.

For what purpose is the exhaust steam to be used? If the presence of oil in any degree is to be avoided, the turbine should be selected. What is the load factor? If the load varies widely, the turbine should be used, due to its flat water rate. If the unit is to be overloaded at times, the turbine is the proper choice, as its efficiency under overload does not materially decrease, unless overload bypass valves are used, which are unusual in small units.

The turbine will take up less space than an engine of the same rating and is better for high speeds. An engine is better at lower rotational speeds, or where variable speed or reversing is desired.

All things being equal, a compound engine will cost somewhat more than a turbine of equal size; but the maintenance will be less.

B. A. WEIMER,
Carrick Engineering Company.
Chicago, Ill.

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INSOFAR as pressure and temperature are concerned, either unit will operate satisfactorily. Other factors should be considered. In your process would you demand oil-free steam? This one requirement might be the deciding factor. Are your power and process loads nearly balanced? If not—which is the greater? You can certainly get 500 kw. from an engine for less steam than a turbine, but if your process demands more steam than the turbine produces it is of no consequence what amount of steam it consumes. Would you have a standby unit?

When it comes to major repairs, the engine would be preferred. For instance, to reblade a turbine would take a week; in fact, most builders prefer to have the shaft shipped back to the shop. To rebore a cylinder of an engine is a matter of a few days; most engines are rebored between Saturday noon and Monday morning. Again, an engine can usually run on makeshift repairs, where a turbine could not.

Does noise enter into any consideration? In some cases the whirr of a turbine would be objectionable. Piping is another consideration. The turbine would take smaller pipe, valves and fittings.

First cost favors the turbine; long life the engine. The only real answer is an unbiased analysis of the conditions existing in the particular plant.

THOMAS A. WALSH.
Watertown, Mass.

Recent Publications

Steenkool (Coal). By J. J. Bootsgezel, Inspector of Government Collieries. Netherlands. Published by A. E. Kluwer, Deventer, Netherlands. Cloth; 437 pages, 348 illustrations. Price, 15 florins (about $6).

THIS is a general work, in Dutch, on the occurrence, winning and treatment of coal throughout the world, with particular reference to Dutch practice. Mining equipment; washing and other preparation machinery; and coke ovens, gas works and byproduct recovery installations of all the important types are covered in a brief way, with many clear and helpful illustrations.

Vibration Problems in Engineering. By S. Timoshenko. Published by D. Van Nostrand Company, 8 Warren St., New York. Cloth; 6x9 in., 231 pages. Price, $4.50.

AT SOME time during the design of all high-speed rotating machinery serious consideration must be given to those problems that have to do with balance and vibration. In this book Mr. Timoshenko develops, in a rather mathematical way, the fundamentals of the theory of vibration. Examples, in many cases taken from actual experience, are given to illustrate the application of this theory to the solution of technical problems. In its four chapters are discussed harmonic vibration of systems having one degree of freedom, non-harmonic vibration of systems having one degree of freedom, systems having several degrees of freedom and vibration of elastic bodies. In an appendix various instruments available for measuring both the amplitude and frequency of vibrations are described.

Steel Pipe Nipples. Issued by the United States Department of Commerce. Published by the United States Government Printing Office, Washington, D. C., 1929. Paper; 9x5¾ in.; 18 pages. Price, 10 cents.

IN JUNE, 1928, a joint committee of manufacturers, users and others interested accepted a commercial standard for steel pipe nipples. Working in co-operation with that committee, the Department of Commerce recently has published its recommendations as CS5-29. This booklet, in addition to giving a list of the acceptors, details the requirements that must be met by manufacturers who wish to adhere to the new standard and gives general information regarding the make-up and functions of the committee responsible for the inauguration and carrying out of the project. Provision has been made for regular annual revision of the recommendation, which went into effect Jan. 1, 1929.

How to Employ and Use Services of Practicing Engineers. Prepared by the Committee on Services and Fees for Practicing Engineers of the American Association of Engineers. Published by the American Association of Engineers, Chicago, 1929. Paper; 9x6 in.; 30 pages. Price, 25 cents.

THIS pamphlet was prepared for the information of prospective employers of engineers and for the use of the engineers themselves. It aims at more uniform and more satisfactory relations between engineers and their clients. The booklet is divided into several sections, treating with: The employment and use of engineering services (information of value to prospective clients), a typical engineering contract, minimum recommended fees for services, and a code of practice. The bulk of the pamphlet, which is a reprint of a report adopted by the fourteenth annual convention of the association at El Paso, Texas, deals in a most satisfactory manner with fees to be charged and ethical practices.

The Economics of Water-Power Development. By Walter H. Voskuil, Assistant Professor of Industry, Wharton School of Finance and Commerce, University of Pennsylvania. Published by the McGraw-Hill Book Company, Inc., 370 Seventh Ave., New York City, 1928. Cloth; 5½x8 in.; 37 tables; 26 illustrations; 225 pages. Price, $3.

AS THE title indicates, this book is a treatise on the economics of water-power development. During recent years a great mass of material has been published on this subject, in which many conflicting opinions have been expressed. In this work the author has attempted to analyze the factors governing the economic exploitation of water power and to give a résumé of how these resources have been developed in this country and Canada.

The range of subjects covered is indicated by the eleven chapters: Water power and the power problem; elements of the water-power plants; principles of water-power development; the St. Lawrence drainage basin; water powers of the Southern States; the Colorado River; water powers of the Pacific drainage area; the development of isolated water powers; public control of water powers; public ownership projects; foreign water powers.

A major feature of the book is the two chapters dealing with public control of water powers and public ownership projects. The author expresses the belief that public opinion in Canada and the United States stands unequivocally for a public interest in water-power development. This opinion is expressed in the laws of the provincial and state governments, in federal law in the Act of 1920, in various proposals now before the public which seek to enlarge still further the control of government over water-power development. This guardianship over the water power, to Mr. Voskuil, seems to indicate definitely a change in public opinion toward a closer supervision of the disposition of the natural resources of the country.

In the chapter on "Public Ownership Projects" the various public ownership projects are reviewed, as well as the tendency to consolidation by private companies, and the author says: "The stake of the public is a cheap and reliable supply of power, widely distributed and available to all."

In this book there has been correlated a mass of valuable information on water-power development, and it has been presented in an attractive style. Those interested in these developments should find this work worth while.

Analyses of West Virginia Coals (Technical Paper 405). Issued by the Bureau of Mines, U. S. Department of Commerce. Published at the Government Printing Office, Washington, D. C. Paper; 344 pages. Price, 20 cents.

THE bulk of this book is devoted to tabulated data on analyses of mine samples gathered in hundreds of mines in West Virginia. Field notes describe the coal bed worked and its characteristics, the places where the samples were taken and the general condition of mining. Analyses of delivered coal indicate what the consumer is likely to receive, but there is some variation in the results of sampling, and even though the same coal is sampled a number of times the analyses do not always exactly agree. Geology of coal formations, characteristics and distribution of coals, and mining methods and transportation are treated briefly.

Low-Voltage A. C. Networks. By D. K. Blake. Published by the General Electric Company, Schenectady, N. Y. Paper; 11½x8½ in.; illustrated; 40 pages.

MODERN conditions of energy supply in metropolitan districts have reached a point where serious thought is being given to the service possibilities of low-voltage alternating-current networks. The introductory considerations are outlined in this booklet, which consists of reprints from nine issues of the *General Electric Review*. Lamp flicker, load division, secondary cables, protection, relay characteristics and transformer equipment are discussed in their relation to low-voltage networks.

Welding, Brazing and Soldering Monel Metal and Pure Nickel (No. 1 Working Instructions) is a seven-page booklet covering the important points of the processes described. It is issued by the International Nickel Company, Inc., 67 Wall St., New York.

Current Events in the Field of Thermal Research

By A. A. Potter

Dean of the Schools of Engineering and Director of Engineering Experiment Station, Purdue University

1. *Association for Correlating Thermal Research*—The research laboratory of the American Society of Heating and Ventilating Engineers, at Pittsburgh, Pa., is the headquarters of this association. In its 1929 directory it lists investigations which are carried on by twenty-seveen engineering colleges in the United States and in Canada, three United States Government bureaus, twenty societies and associations, and twelve private laboratories. Most of the investigations relate to heating and ventilating of buildings. Studies listed of interest to the power industry include:

(*a*) Steam properties and development of steam tables, at the Stevens Institute of Technology.

(*b*) Thermal properties of steam, at the United States Bureau of Standards.

(*c*) Flow of vapors and of gases, at the Virginia Polytechnic Institute, Blacksburg, Va.

(*d*) Heat dissipation from steam pipes, at Montana State College, Bozeman, Mont.

(*e*) Development of a standard code for testing and rating gas-fired boilers, at the American Gas Association Testing Laboratory, in Cleveland, Ohio.

(*f*) Development of code for testing fans, by the National Association of Fan Manufacturers, at Chicago, Ill.

(*g*) District heating, under the National District Heating Association.

(*h*) Heat transmission research is being encouraged by the National Research Council, Washington, D. C.

(*i*) Research in connection with air conditioning, by the Carrier Engineering Corporation.

(*j*) The National Tube Company, at Pittsburgh, Pa., is carrying on investigations in connection with the manufacture and utilization of pipe, with particular reference to the effect of impure waters.

2. *Surface-heat Transmission*—At the Rochester meeting of the American Society of Mechanical Engineers (May 13-16, 1929) R. H. Heilman, senior industrial fellow of the Mellon Institute of Industrial Research, presented a paper in which he gave the results of his investigation of surface-heat transmission.

The method used in this investigation was to measure the total rate of heat loss under given temperature conditions for a lampblack-covered brass disk, heavily silver plated, containing an electric heating element, and later under the same conditions, except that the disk surface was highly polished. The difference between these two measurements gives the difference in radiation for lampblack and polished silver surfaces. At the same time that the power measurements were taken, the ratio of radiation from the lampblack surface to that of the highly polished silver surface was obtained from the deflection of a sensitive radiometer. Having the difference in radiation from the power measurements and the ratio of the two radiations from the radiometer, the absolute value of each was computed. The radiometer was also calibrated so that its readings gave the actual losses by radiation from any surface to which the radiometer is exposed. This method of procedure was used not only to determine the radiation loss from various surfaces but also to measure the amount of heat lost from the same surface by convection.

Emissivity values at temperatures of 100 to 700 deg. F. were obtained for various surfaces, including asbestos paper, rough steel plate, lampblack, polished silver and lacquer. At 500 deg. F. these were found to vary from 0.0295 for silver to 0.929 for asbestos, 0.945 for lampblack, and 0.969 for rough steel plate.

The charts which accompany this paper make possible the determination of the total heat transmitted by convection and by radiation for surface temperatures up to 700 deg. Fahrenheit.

3. *Thermal Research by the United States Bureau of Mines*—The publications of the U. S. Bureau of Mines contain much of the most authoritative data about fuels in the United States. The list of publications by the Bureau of Mines for 1910-1920 includes 292 bulletins and 437 technical papers. Among these publications the following contain valuable thermal data:

Bulletin 8, "Flow of Heat Through Furnace Walls." (1911.)

Bulletin 18, "The Transmission of Heat Into Steam Boilers." (1912.)

Technical Paper 114, "Heat Transmission Through Boiler Tubes." (1915.)

4. *Thermal Research by Engineering Colleges*—

(*a*) The University of Illinois engineering experiment station has published the following bulletins on this subject:

No. 11, "Effect of Scale on the Transmission of Heat through Boiler Tubes." (1907.)

No. 36, "The Thermal Conductivity of Fire Clay at High Temperatures." (1909.)

No. 40, "Study in Heat Transmission." (1909.)

No. 168, "Heat Transmission Through Boiler Tubes." (1927.) This investigation is being continued.

Bulletins 171 and 186, "Heat Transfer in Ammonia Condensers." (1927, 1928.)

(*b*) The Massachusetts Institute of Technology has in print the following contributions on heat transfer from the Department of Chemical Engineering:

Serial 4, "Heat Transfer by Conduction and Convection." I.

Serial 5, "Heat Transfer, Condensing Vapors."

Serial 8, "The Effect of Air in Steam on the Coefficient of Heat Transmission."

Serial 77, "Heat Transfer by Conduction and Convection." II. (1923.)

Serial 174, "Heat Transmission from Condensing Steam to Water in Surface Condensers and Feed Water Heaters." (1926.)

(*c*) The University of Missouri engineering experiment station has published Bulletin 18 on "Heat Transmission Through Boiler Tubes." (1916.)

(*d*) Cornell University engineering experiment station has published Bulletin 7 on "The Heat Transfer from Steam to Heavy Fuel Oil." (1927.)

(*e*) The Ohio State University engineering experiment station has among its publications, Bulletin 31, on "Thermal Conductivities of Alloys." (1925.)

(*f*) The Pennsylvania State College engineeing experiment station publications include:

Bulletin 24, "Report on the Thermal Testing Plant for 1916-1917."

Bulletin 30, "Heat Transmission, Cookboard and Air Spaces." (1920.)

Bulletin 32, "Heat Transmission and Efficiency of Steam Boiler Tubes." (1924.)

Among the investigations now under way at the Pennsylvania State College are studies of surface transmission of heat, and effect of air velocity, humidity and moisture absorption on thermal conductivity.

(*g*) The University of Wisconsin engineering experiment station publications inclure Reprint 1, "Heat Insulating Properties of Commercial Steam Pipe Coverings." (1915.)

X-Rays in Industry—To those who have associated X-ray photography with certain phases of medical and dental science only, the extent to which it may be applied to industrial practice will come as a distinct surprise. A booklet, "X Rays in Industry," recently issued by the Eastman Kodak Company, of Rochester, N. Y., dealing with the use of X rays in the determination of the internal structure of materials, will be of real interest to power engineers. The booklet contains illustrations showing X-ray photographs of work done at the Edgar Station of the Boston Edison Company, at Weymouth, Mass. All pipe and fittings for the 1,200-lb. steam line and the cast shell of a 3,000-kv. steam turbine were examined. Some of the parts found to contain flaws probably would have been accepted under any other test.

Photographs, showing flaws revealed by the X ray in welded joints, ball bearings, and castings of various kinds, are included. A brief summary of the theory of the X ray and methods of use, as well as a bibliography on X rays in industry, are contained in the booklet.

Maintenance of Large Diesel Engines*

By Louis R. Ford

United Dry Docks

THE great increase in Diesel-engine-driven vessels has become an important factor in the ship-repair yards, where it has had a profound influence in modifying old and stimulating the development of new methods and procedure. Maintenance and repair of ships and their machinery is essentially a shipyard function, because the watch-keeping requirements and lack of adequate facilities on board ship limit the engine-room personnel to comparatively minor maintenance work. The ship-repair yard, then, offers a very good point of contact where accurate and comprehensive information regarding structural details, operative requirements, and comparative performance of miscellaneous designs can be obtained.

A large ship-repair organization will be called upon to render service to several thousand ships each year, and among these will be vessels of all nationalities, all sizes, having all types of machinery. The great increase in the number of motorships has resulted in a growing percentage of such ships in the total number of vessels that must be serviced each year, and the work carried out will vary from the replacement of some minor part to the complete rebuilding of the entire power plant.

Qualified Machinists Required

Experience has developed the fact that for work on the marine Diesel engine, especially for fitting up and assembly on board ship, machinists with rather special qualifications are required. The ordinary requirement, skill in mechanical work, should be supplemented by thoroughness, patience and dependability, as well as by some understanding of the fundamental differences in the nature and functions of the elements of the Diesel and steam plants.

The necessity for thoroughness arises from the fact that it is not practicable constantly to supervise the work of each individual, and is illustrated by an extensive repair job to a piston-cooling service recently executed by the author. In this case the brackets supporting the swinging pipes used for conveying cooling oil to and from the pistons were secured by studs with castellated nuts, the usual hole being provided in the stud for inserting a cotter pin. During assembly at the works of the builder the castellations on some of the nuts did not line up with the holes, and the nuts were backed off by a careless workman until the cotter pins could be inserted. This left several nuts loose, and during operation of the engine at sea the brackets carried away, causing the heavy swinging arms to smash things up pretty badly before the engine could be stopped. Aside from the possibilities of breakage such as this, lack of thoroughness may necessitate some very expensive work to correct some very minor defect that is buried in the accessory structure of the engine.

During recent installation of a new engine, a preliminary test of air lines after erection disclosed a leak at the junction of the high-stage compressor discharge pipe and the aftercooler coil. Investigation disclosed that the small collar on the end of the copper pipe of which the coil was formed was brazed only on one side. The actual brazing needed to correct this defect required only about 30 min. in the shop, but so much of the engine structure had to be dismantled to get the coil out that it required four men working three days to remove and replace it.

The construction of the steam engine, the steam boiler, and the steam turbine and their arrangement in ships are standardized sufficiently to permit standardizing many repair operations on them, and reducing to a standardized basis the cost estimating for these operations.

A different situation exists when considering repairs to motor-ship machinery. Here we find a most troublesome lack of finality or permanence in design. To the repair man it appears that no Diesel-engine design ever stays put. It is true that some engine builders have achieved a certain degree of standardization, such as adopting a standard cylinder size and making up different engines by assembling different number of cylinders, but it is the minor or accessory parts that cause the most trouble. It is seldom that even sister ships, built to one order by the same builder, have machinery that is exactly alike in every detail. An example of this is a crankshaft job carried out by the author. The coupling bolt holes in the crankshaft of a 5,000-hp. engine had to be reamed and new bolts, about 4 in. in diameter, fitted. A special set of reamers and a special machine to drive them were manufactured. Shortly afterward the engine of a sister ship, apparently a duplicate of the first, required the same job, but after the work was started it was found that the couplings on the second engine, instead of having straight holes as had the first one, were fitted with tapered bolts. This necessitated manufacture of a second set of special reamers, at a cost of about $200.

Such variations in details of construction or arrangement of parts often have a legitimate reason, resulting from the unusually rapid advance in the art of Diesel-engine design or from experience with similar engines in service, but just as often it represents the yearning to express individuality that every designer seems to feel.

Motorship repairs, in general, may be grouped into three classes as follows: (1) maintenance repairs, or those resulting from ordinary wear and tear in service; (2) repairs required as a result of faulty design, or changes due to improvement in design; and (3) repairs required as a result of accident, stress of weather, or other unusual conditions. To these might be added another classification less clearly defined, namely, unnecessary repairs—unnecessary in the sense that the need for them arises from preventable causes. One of the most common sort of jobs in this latter class is the repair or replacement of cylinder heads, liners and pistons that have cracked as a result of accumulation of scale and sediment in the cooling-water spaces.

Scale Causes Fractured Heads

A case was brought to the author's attention where a cylinder head cracked, although it was on an engine the manufacturers of which went to unusual length in designing a head that would be readily accessible in all parts for cleaning. Examination of this head showed the water space to be almost entirely filled with hard scale. Experience with many cases similar to these two has convinced me that keeping the water sides of heat-transmitting parts free from insulating deposits of scale, sediment, grease, and rust does not receive the attention it deserves from either engine builders or engine users. Periodical and thorough cleaning of all water jackets, whether the cooling water be fresh or salt, should be just as much of a routine procedure on the motorship as periodical boiler cleaning is on the steamship. In fact, the whole subject of what may be termed "preventive treatment" should receive more attention than it does. Most bedplate troubles arise from the surprising flexibility of what is usually a massive structure of cast iron. An example of this was the bed of a 500-hp. engine that had been carefully reset to correct an original misalignment. After accurate alignment was complete and the bed was resting on permanent steel chocks, the spaces between chocks was closed with wooden filler pieces, as is the usual custom in marine work. It was found that too thick a filler piece driven under the bed at about its center with an ordinary hand hammer bowed up the bed enough to throw the coupling on the end of the crankshaft measurably out of line.

Cylinders, or what may more precisely be termed cylinder jackets, give very little trouble, although on some of the older engines an occasional cracked cylinder will be found. Cylinder liners, however, are a prolific source of work for the repair yard. Liner casualties occur either from wear

*Paper read at national meeting, Oil and Gas Power Division, A.S.M.E., Pennsylvania State College, June 26, 1929.

ror cracks. Wear is a normal result of engine use, but it sometimes assumes abnormal proportions if operating conditions are not right. Of course, the liner material has some bearing on rate of wear in service and there is some variation in the quality of liner iron found in different makes of engines, but there is not enough variation to make this an important factor in differences in length of liner life found in service. What appears to be the most important factor is the fuel used. Some fuel will contain more abrasive impurities than others, but it is my belief that all fuel oil, even the highest commercial grades, should be passed through a centrifuge before being used in the engine. An example of the value of the centrifuge is the case of two sister ships of 2,000 hp. After a trip around the world, both using the same kind of fuel, it was found that liner wear amounting in one cylinder to 0.270 in. had occurred in one vessel, necessitating the renewal of that liner, while in the sister ship the maximum liner wear observed was 0.025 in. The difference is accounted for by the fact that in the first ship the fuel, which was very dirty, had been, during a portion of the voyage, used directly from the tanks, while in the second no fuel was used without contrifuging.

Various estimates have been made as to what should be considered normal length of life for a liner, and although there is wide divergence of opinion, experience seems to indicate five years as the average. We are learning more about how to make cast iron that will withstand wear and yet not be too hard to machine easily. We can expect longer-lived liners in future engines. It is seldom that the repair yard is required to rebore Diesel-engine liners. Even though the liner be amply thick for reboring, the necessity for supplying an oversize piston after such reboring makes it cheaper to install a new liner.

The head is usually the most complicated casting on the engine, and as such suffers most from heat troubles. The usual head repair is welding of cracks. Both oxyacetylene and electric welding are used, but the former is preferred if the location of the crack will permit its use. If the crack is near the outer edge of the head, where expansion and contraction stresses can be accommodated, the gas welding can be used, but if the crack is near the center of the head or surrounded by unsymmetrical masses of metal, as is usually the case, electric welding must be resorted to. To make a successful head repair, electric welding must be done very skilfully and studding employed. Where a weld crosses a valve-housing seat, as was the case with one head, great difficulty is experienced in machining the seat accurately, due to the cutting tool's springing when it strikes the junction between new and old metal. This difficulty has been met by the use of tungsten carbide tools, which cut the hard metal with ease.

Breakage of crankshafts in years gone by was accepted as one of the hazards inherent in Diesel-engine operation, but at the present time such breakage is very unusual. Most repair work on crankshafts consists of refinishing pins and bearings that have become scored or worn, or correcting alignment of the shaft in its bearings. Whenever it is necessary to renew a broken shaft, it is found that breakage is due to misalignment or torsional vibration. Wear of main bearings is more rapid in marine engines than in land engines. The more flexible nature of the structure on which the engine rests, as compared to the mass of concrete under the land engine, makes it more difficult to maintain a continuously unbroken oil film between shaft and bearing box.

Piston-rod troubles may be said to be non-existent in single-acting engines that have such rods, but in the newer double-acting designs piston-rod breakage has been rather common. These breakages have resulted from both incorrect design and improper material,

Diesel engines are not standardized sufficiently to make repairs low priced.

Welding of cylinder heads and piston crowns is successful.

Piston rods give no trouble when correct materials are used.

Life of cylinder liners is five years on a well operated engine.

but in all the cases that have come to the author's attention the original defects have been removed, and there is no reason to believe that piston-rod breakage need, in the future, be regarded as a feature of double-acting engines. Experience with such materials has demonstrated that for piston-rod manufacture it is not wise to use alloy steels of a type the physical properties of which cannot be accurately controlled and on which the effects of heat treatment cannot be accurately predicted. One set of large double-acting rods renewed by me was made of a chromium alloy steel, to which the builder was rigidly restricted by the purchaser of the engine. When the rods were removed after a short period of use, the heavy buttress threads at the crosshead ends could be peeled off like unwinding a string.

From the repair man's point of view, the piston seems to be the most troublesome of all the major parts of the Diesel engine. The trouble encountered is usually cracking, or wear of ring slots. There are two ways in which cracking occurs: approximately radial cracks develop in the crown or circumferential cracks in the side or skirt. The first is the most common kind, and the appearance of the cracks indicates that it is associated with the phenomenon of metal growth by repeated heating. The second type of fracture, cracks in the sides, is almost invariably due to piston seizure in the liner and is usually associated with cooling-system failure. Welding procedure has been developed to the point where most cracked pistons can be salvaged at a cost substantially less than the price of a new one. As compared with welding of cylinder heads, piston welding is much easier, because of the more symmetrical disposition of the metal.

As in the case of cylinder heads, either gas or electric welding can be used, but the former is much to be preferred. It can be used successfully, however, only when the piston can be preheated. The procedure is as follows: All burned metal in the vicinity of the cracks is cut away by drilling, then an air chisel is used to cut a wide V along the line of each crack. In each case the V must extend the full length and depth of the crack. If the crack goes clear through, the tip of the V must just penetrate the inner face of the metal. If a furnace large enough to take the piston is available it can be used for heating, but otherwise a simple furnace can be made by building up a checkered wall of firebrick surrounding the piston, then wrapping asbestos paper around the wall, leaving a draft opening at the bottom. A sheet of asbestos board is laid over the top with a small opening left for draft. A charcoal fire is used to heat the piston up slowly and evenly to a cherry red. Then the welding operation is started through a small opening in the asbestos directly over the spot to be welded. Because of the great heat, usually two welders working alternately are required. After the V's have been filled up carefully and the new metal consolidated with the old.

In conclusion, it seems fitting to consider the much-discussed but never-settled question of relative cost of Diesel-engine repairs and steam-engine repairs. Repair costs are affected by so many variable factors that it is difficult to state conclusions that will be all-embracing. Most important of these factors is operating personnel. A widely used yet incorrect sales argument is that "any one can run a Diesel engine." As a matter of fact, the effect of ignorant or unskilled operation will be reflected in the repair bills for the Diesel engine much more quickly than for the steam plant. It is quite possible and not infrequently happens that the engine-room force for a steamship may be picked up on the waterfront a few hours before the ship sails, and if the engineers are accustomed to operating marine steam plants they find everything about the same as on the last ship on which they sailed. On the other hand, a Diesel engineer may be very familiar with some one particular make of engine, yet require some time to learn the details of another make and the operating procedure required for it.

Events and Men in Power's Field

THE EDITORS WILL WELCOME THE CO-OPERATION OF READERS IN REPORTING INTERESTING HAPPENINGS, PERSONAL OR OTHERWISE

*Spot * News*

NO STATE LAW *has been violated by the formation of the Niagara Hudson Power Corporation, a $450,000,000 utility merger created recently by J. P. Morgan & Company, is the final opinion of State Attorney General Hamilton Ward of New York.*

* * *

HENRY FORD *will reproduce the world's first hydro-electric generating station, which was located at Appleton, Wis., for permanent exhibition in the new Ford Museum at Dearborn, Mich. The Appleton plant was placed in service in 1882 and is regarded as the first from which electricity produced by water was distributed commercially.*

* * *

THE TOTAL HORSEPOWER *of marine steam turbines being built and installed in all countries except Germany showed a decline from 484,600 at the end of March to 429,700 at the end of June, according to reports received by the Department of Commerce.*

* * *

BOTH THE PACIFIC GAS & ELECTRIC COMPANY *and the Great Western Power Company have applied to the California Railroad Commission for a rehearing of its recent decisions fixing the prices to be paid by the city and county of San Francisco for the two companies' systems within the city.*

* * *

JUNE OUTPUT *of electric energy produced by the International Paper & Power Company system was 364,317,000 kw.-hr., an increase of 30 per cent over the output for June, 1928. In the first six months of this year, the output of the company was 2,284,956,000 kw.-hr., 40 per cent greater than last year.*

* * *

WATER-POWER RIGHTS *to the last great power source in New York State, outside of Niagara and the St. Lawrence River, are being negotiated for by the Mohawk Hudson Power Corporation. A development of 75,000 hp. is planned for Hudson Falls.*

* * *

ETHANE GAS, *a new product of the Carbide & Carbon Chemicals Corporation, was used instead of Blau gas as fuel gas on the latest trip of the Graf Zeppelin. Ethane is slightly lighter than air and has a high B.t.u. content.*

Papers Announced for Tokyo Meeting of World Power Conference

Japanese, German, Swiss, Czechoslovakian, Danish, Swedish, Italian, Russian and American Dissertations to Cover Every Aspect of Power

PLANS are practically completed for the sectional meeting of the World Power Conference to be held in Tokyo, Japan, Oct. 29 to Nov. 22. Technical sessions will be held from Oct. 29 to Nov. 7, and excursions in Japan will take up the rest of the time devoted to the meeting. Papers to be presented at the sessions treat all phases of power generation, distribution and finance. Though a few papers may be added before the meeting opens, the following list is fairly inclusive of their scope:

JAPANESE PAPERS

Section A

A suggestion for Utilization of Tidal Power. By U. Shinohara, Imperial University of Hokkaido.

Present Status and Future Possibility of Wind Power. By T. Motowoka, Civil Engineering Department of Tokyo Municipality.

Commercial Production of Gasoline Substitute. By S. Hori.

Utilization of Terrestrial Heat for Power Generation in Japan. By H. Tachikawa, Tokyo Electric Light Company, Ltd.

Development in the Demand of Motor Oil in Japan. By Nippon Oil Company, Ltd.

Recent Discovered Soft Coal, Metamorphosed by Igneous Intrusives as a Domestic Fuel. By A. Naito, Naito Fuel Research Laboratory.

Coal Resources in Japan. By H. Watanabe, Geological Survey, Department of Commerce and Industry.

Petroleum Resources in Japan. By K. Chitani, Mining Bureau of Department of Commerce and Industry.

Utilization of Korean Anthracite and Lignite. By Y. Takeda, Fuel and Ore Dressing Institution, Korean Government-General.

Section B

Utilization of Low-Head Water Power. By Y. Yamagata, Tenryugawa Electric Power Company.

Economic Co-ordination of Power Generated Thermally and Hydraulically. By S. Fukunaka, Nihon Electric Power Company, Ltd.

Reservoir for Hydraulic Power Plant. By S. Sugiyama, Mahagi Hydro-Electric Company, Ltd.

Electrical Interference Between Aerial Communication Lines and Super-High-Tension Transmission Lines. By R. Mitsuta, Electric Research Institute, Department of Communications.

Economic Limit of Spare Machine on Electrical Institution. By S. Fukunaka, Nihon Electric Power Company, Ltd.

Thermal and Hydraulic Power Generation in Central Japan. By I. Hirose, Engineer, Toho Electric Power Company, Ltd.

Interchange of Electric Power Among Principal Localities of Load Center in Japan. By Y. Wakawomi, Director, Toho Electric Power Company, Ltd.

Present and Future Conditions of Rate and Tariff System for Sales of Electric Power in Japan. By Y. Wakawomi, Director, Toho Electric Power Company, Ltd.

Estimation of Substantial Cost in Electrical Enterprises. By Y. Wakawomi, Director, Toho Electric Power Company, Ltd.

Royalty Contract for the Municipalities in Respect of Electrical Installations in Japan. By K. Tsunada, Director, Toho Electric Power Company, Ltd.

Rationalization of Electric Industry in Japan. By D. Ide, Secretary General, Toho Electric Power Company, Ltd.

Some Particular Technical Points in the Japanese Electrical Enterprise Law Regulation. By Dr. G. Shibusawa, Tokyo Imperial University.

Control of Rate and Tariff for Gas and Electricity Supply in Cities. By K. Goto.

Water Power Development in Japan. By H. Morik Electrical Bureau, Department of Communication.

Determination of the Order of Economic Development of Water Rights for Electric Generation in Japan. By H. Tachikawa, Director, Tokyo Electric Light Company, Ltd.

Equipment for Power Generation of Fuenko in Korea. By K. Morita.

Joint Operation of Thermo and Hydraulic Power. By G. Masunaga, Director, Bureau of Electricity, Imperial Government Railways.

Inter-Connection of Power Transmission Lines. By E. Aoyagi, Prof. of Kyoto Imperial University.

Conditions for Granting Electric Enterprises. By J. Murai, Director of Electric Bureau, Department Communication.

Legislation and Revision on the Laws Governing Water Rights for Electric Power Generation. By J. Masuda, President, Daido Electric Power Company, Ltd.

Operation and Improvements on the Efficiency of Producing, Transforming, Transmitting and Distributing Installation for Electric Power. By S. Kondo, Director, Daido Electric Power Company, Ltd.

Administration of Electric Enterprises and Monopoly of Electric Power in Japan. By R. Koyama, Engineer, Yakagi Hydro-Electric Power Company, Ltd.

Economic Consideration of the Elec-

trification of the Trunk Line in Japan. By Japanese Government Railways.

Section C

Recent Development of Electromobile in Japan. By Dr. M. Fukuda, Kobe Technical College.

Economic Consideration of Car Ferry Between "Aomori" and "Hokkaid." By Japanese Government Railways.

Economic Comparison Between Motor Car and Local Railway Services for Branch Lines. By Japanese Government Railways.

Funicular Railway in Japan and Their Economic Feature. By Japanese Government Railways.

Petrol vs. Steam Engine for Use in Trawl. By T. Tajima, Marine Bureau of Department of Agriculture and Forestry.

Aerial Transportation in Japan. By S. Hisamatsu, Tokyo Ashai Shimbun.

Motor Ship. By T. Kawamura, Mitsui & Company, Ltd.

Section D

Development of Water Wheel and Its Economical Relation in Japan. By M. Tazawa, Dengyosha Prime Mover Manufacturing Company.

Diesel Engines in Japan. By K. Ino, Mitsubishi Ship-Building & Engineering.

Synthetic Fuels and Lubricating Oils. By A. W. Nash, Institute of Fuel.

The Storage of Steam. By E. G. Richie, Institute of Fuel.

Volumetic Measurement of Coal and Coke. By J. E. Lee.

Condensing and Non-condensing Steam Turbine Locomotives. By James MacLeod.

Gas Liquor Effluents. By Dr. A. Parker, the Institution of Gas Engineers.

The Evolution of the Continuous Vertical Retort. By Sir Arthur Duckham, the Institution of Gas Engineers.

Pulverized Fuel and Its Various Fields of Application. By Blythe, Institute of Fuel.

AMERICAN PAPERS

Economic Results of Railway Electrification. By A. I. Totten, Railway Engineering Department, General Electric Company.

Large Power Transformers, Some Economic Aspects Affecting Their Design. By F. F. Brand and H. O. Stephens, Transformer Engineering Department, General Electric Company.

General Trend of Steam Turbine Development. By Ernest L. Robinson, Turbine Engineering Department, General Electric Company.

Some Phases of Ship Propulsions as Influenced by Modern Power Plant Engineering. By R. A. Beekman and A. Kennedy, Jr., Marine Department, General Electric Company.

High Pressures and High Temperatures in Power Generation. By George A. Orrok.

Electric Line Extension in Rural Communities. By Wellington Rupp.

American Power Station Electrical Equipment. By Newbary, General Electric Company.

Electrical Energy Produced Thermally. By Bushnell.

Frequency and Voltage. By Argensinger.

Control and Supervision of the Electricity. By H. B. Sawyer.

The Operation of Turbine-Generators by Total Temperature Instead of Temperature Rise. By W. J. Foster, P. Torchio and Newbary.

Recent Progress in Combustion Engineering. By Combustion Engineering Corporation

The Present Status of Public Utility Regulation in the United States of America. By W. H. Blood, Jr.

The Thermal Electric Plants. By Frank S. Clark.

A STEAM plant in the heart of the Canadian Rockies supplements the hydro-electric plants of the East Kootenay Power Company. This 10,000-kw. "Sentinel" steam-electric station, located on the shores of Crows Nest Lake, Alberta, permits full use of the company's developed water power.

GERMAN PAPERS

Recent Developments of the Bauer-Wach Exhaust Turbine. By Prof. Dr.-Ing. E. H. G. Bauer.

The Development and Problems of Central Heating, especially of Cities in Germany. By W. Ellrich.

The Influence of the Propeller and Kaplan Turbines on the Construction of Water Power Plants. By Dr. Hahn-Obering Maas, Escher Wyss & Company.

The Significance of the Ruths Accumulator in Steam Engineering. By Geh. Regierungsrat Prof. Josse.

Stability and Waterproofness of Dams. By Dr.-Ing. N. Kelen.

The Development and Prospects of High-Pressure Steam Installations in Germany. By Dr.-Ing. E. G. Mayer, General Manager of the Grosskraftwerk Stettin.

Some Results of Research Work at the Hydraulic Laboratory of the Technical University at München. By Dr.-Ing. D. Thoma, of the München Technical University.

New Developments of Diesel Engines in Germany. By Dr.-Ing. Nagel.

Methods of Economical Steam Generation and Its Utilization. By Dr.-Ing. Pauer, professor at the Dresden Technical University.

The New Tendencies in the Development of the Turbines for Process Work. By Dr.-Ing., Dr.-Techn. H. C. Ernest A. Kraft, professor at Berlin University.

Character and Application of Back Pressures on Bleeder Turbines. By Dr.-Ing., Dr.-Techn. H. C. Ernest A. Kraft.

CZECHOSLOVAKIAN PAPER

Present Development of Highly Efficient Heat Engines. By Von E. Korndorfer.

SWISS PAPERS

The Zoelly Steam Turbine Locomotive, With Special Reference to High Pressure

Steam Turbines. By Dr. H. Zoelly, Escher Wyss & Company.

The Development of the Francis Turbine, With Special References to the Recent Researches Made by Escher Wyss & Company. By J. Moser and E. Seitz, Escher Wyss & Company.

On Supercharging Diesel Engines. By the Swiss Locomotive Company.

Balance Between the Supply and the Consumption of Energy. By the Manager of Sulzer Brothers Engineering Office, Japan.

The Heat Economy of the Steam Locomotive.

The Mechanical Factor of Safety of Large Turbine-Generators. By H. Richli.

The Influence of Friction and Mass Power on the Course of Tooth Pressures and the Importance of Grinding Heavily Loaded, Rapid-Running Gear Wheels. By H. Braudenberger.

Danish Papers

Power Production and Consumption in the Cement Industry. By O. V. Mörch.

Coal Studies, Extraction of Coal With High Boiling by Organic Compounds. By Peter Esch Raaschou.

Propulsive Machinery for Ships, With Special Regard to the Development on Marine Diesel Engines. By H. H. Blache.

Modern Danish Plants for Producing Power as a Byproduct. By T. E. Thomson.

Swedish Papers

The Transmission Plants for Railway Electrification at the Swedish State Railways. By I. Ofverholm.

The General Power Distributing System of Sweden. By W. Borgquist.

Steam Accumulation. By J. Ruth.

A New High-Tension Steam Generator. By J. Victor Blomquist.

The Regenerative Principle Applied to Air Heaters and the Like. By M. Lindhagen.

Preheated Air and Waste Fuels. By M. Lindhagen.

Double Rotating Steam Turbine of High Rating. By M. Lindhagen.

A New Type of Steam Turbine. By M. Lindhagen.

The Steam Turbine as a Locomotive Motor. By M. Lindhagen.

The Most Favorable Relation Between the Heating Surface in the Furnace of the Steam Boiler and the Total Heating Surface. By T. Lindmark.

Turbine Locomotive With Air Preheater. By F. Ljungstrom.

Recent Development of Double-Rotation Turbine for Large Output. By O. Wiberg.

High Pressure or High Steam Temperature for Steam Prime Movers. By O. Wiberg.

Ruth's Accumulators in Japan.

Italian Paper

Utilization of Terrestrial Heat. By Prince Conti.

Russian Papers

The Power Problems of the Soviet Republic. By G. M. Krjyanovsky.

Potential Resources in the Soviet Republic and Their Utilization. By I. I. Radtchenko. Director of the Geological Commission of the U.S.S.R.

Industrial Power and Heat Supply in Soviet Russia and their Development from 1925-26 to 1932-33. By S. Kookel-Krajevsky.

The Achievement of the Highest Electrical and Mechanical Stresses. By F. Yoffe, member of the Academy of Science of the U.S.S.R.

Results Obtained in the Utilization of Various Fuels. By L. K. Ramsin.

Installation of Boiler Room Economies. By L. K. Ramsin.

Influence of High Tension on Telephone and Telegraph Lines, and Their Protection. By K. Tchernichew.

The Growth of Electric Stations in the Locality of Moscow. By B. A. Barsukow and P. G. Grundinsky.

Power Standards and Particular Electrical Problems in Soviet Russia. By D. P. Frieman.

New Steam Plant Near Buffalo Will Have 80,000-Kw. Unit

Within a few months construction will be started on a new steam-electric power plant that will add more than 100,000 hp. to the electrical resources of the Buffalo, Niagara & Eastern Power Company. The new plant will be located on the Niagara River and will be operated in conjunction with the Charles R. Huntley station of the Buffalo General Electric Company. Capacity of the Huntley station is now over 300,000 hp., and with the completion of the new steam plant power generated by steam at Buffalo will practically equal the capacity of the hydro-electric plant on the American side at Niagara Falls, which is the main generating station of the system.

Three boilers fired by powdered coal will be installed and space will be provided for a fourth. Each one of the boilers will be capable of generating 560,000 lb. of steam per hour, and will consume about 30 tons of coal an hour when operating at capacity.

Steam will be supplied at 425 lb. per sq.in. pressure and 750 deg. F. to a generating unit of 80,000 kw. The plant is being started this fall so that its output will be available as the demand rises above the present capacity of the system.

Iowa State College Has Novel Employment Service

An employment service of benefit to the graduate and to industry alike has been established by the Division of Engineering of Iowa State College, Ames, Iowa. In order to avoid the confusion and conflict resulting from the usual systems of securing employment for graduates, the personnel department has published a "Personnel Service Leaflet" punched to fit the standard looseleaf cover containing the information usually requested by prospective employees. Each page contains a picture and complete information for a single student, including his major interests, practical experience, etc. Sets of these leaflets for each year's graduating class are sent to industrial concerns needing men with the particular training given. The leaflets are furnished in attractive leather covers and are sent out about the first of the year.

Water Tube Boilers Increase in First Half of 1929

New orders for 1,685 steel boilers were placed in June, as reported to the Department of Commerce by 80 manufacturers, comprising most of the leading firms in the industry, as compared with 1,751 boilers in May and 1,887 in June, 1928. The following table presents the number and square footage of each kind of boiler ordered for the past six months, including comparisons with the corresponding period of last year:

	Total 6 mos. 1929		Total 6 mos. 1928	
	No.	Sq. ft.	No.	Sq. ft.
Stationary				
Water tube	851	4,960,457	698	3,610,575
Horizontal return tubular	673	903,222	692	888,491
Vertical fire tube	805	247,995	919	269,085
Locomotive (not railway)	147	122,367	223	145,185
Steel heating	5,244	2,549,888	5,814	2,789,517
Oil country	528	514,246	294	255,642
Self-contained portable	290	189,383	320	203,972
Miscellaneous	90	39,510	74	38,814
Total	8,628	9,527,068	9,034	8,201,281
Marine				
Water tube	35	156,453	53	289,639
Pipe	4	3,892	1	1,881
Scotch	52	50,841	71	35,958
2 and 3 flue	2	1,350	4	2,228
Miscellaneous	4	4,248	4	3,998
Total	97	216,784	133	333,704
Grand Total	8,725	9,743,852	9,167	8,534,985

Pressure and Vacuum Gages Are Among Standardization Projects

About 150 national standards that have already been completed, and about 175 other national projects that are now under way are listed in the American Standards Year Book, which has just been issued by the American Standards Association, New York City.

Specifications and methods of test for petroleum products, a code for protection against lightning, standard track gages and car sizes for metal mines, specifications for track work for steam and electric railways, for bare and insulated copper wire and for pipe flanges and fittings have been completed.

New projects initiated include specifications for pressure and vacuum gages, for leather belting, plastering materials, coal mine cars and mine timbering.

Boiler and Radiator Makers Form New Organization

Manufacturers of boilers and radiators recently formed the Institute of Boiler and Radiator Manufacturers to succeed the National Boiler and Radiator Manufacturers' Association. The new organization follows closely the objects of the older association in promoting the interests of the boiler and radiator industry. The institute will provide a central bureau for conducting investigations and taking such action as is necessary for the general welfare of the industry.

Officers of the new institute are H. T. Richardson, chairman; Grant Pierce, vice chairman; and Frederick W. Herendeen, secretary and treasurer.

Baltimore and Dallas to Have New Pumping Stations

Electrical equipment for two new pumping stations has just been ordered from the Westinghouse Electric & Manufacturing Company. One of these plants, known as the Bachman Pumping Station, is located in Dallas, Texas; the other, the Guilford Pumping Station, is in Baltimore, Md.

Three 800-hp., one 400-hp., three 350-hp. and one 125-hp. synchronous motors have been purchased for the Bachman station. All of these except the 125-hp. motor will have pedestal type bearings and will be directly connected to centrifugal pumps. Full magnetic control will be used with a ten per cent speed variation.

In the Guilford station there will be four synchronous motors, each driving centrifugal pumps. Two of the motors are rated 600 hp., 1,200 r.p.m., and two are 400 hp., 1,200 r.p.m. A very interesting control scheme has been worked out by the City of Baltimore engineers and designed by the Westinghouse company. The operation of the station is to be completely automatic and the operation determined by timing devices and float switches. A selector switch is provided to determine what motors and pumps are to be operated and the sequence of operation. The setting of the timing devices is adjustable. The automatic features are furnished in duplicate to insure operation even in case a part of the automatic equipment fails. Control switches are also provided so that an operator in the station can control the operation of the equipment, although normally there is no station operator.

West Sees Growth In Hydro-Electric Projects

Indications that the city of Denver will enter the power business as a means of placing its water system on a paying basis are forecast in the granting of a preliminary permit covering a 79,000-hp. hydro-electric project to the city and county of Denver by the Federal Power Commission. The permit covers the Two Forks Dam site on the South Platte River, and a further permit, involving water rights and a dam site at Eleven Mile Canyon, will be applied for when surveys are completed.

The projects are designed not only to provide power, but also to conserve flood waters when necessary, and to add about 40,000 acre-feet to the city's water reserve. Present plans contemplate the construction of three reservoirs with six power plants, two at each location, to develop a total of 59,250 kilowatts.

Two other hydro-electric developments on the West Coast are also being planned. Permits have already been issued to the Pacific Development Company, Olympia, Wash., granting the use of 1,050 sec.-ft. of water from the Nisqually River for a 26,820-hp. project to cost $1,500,000. A 230-ft. dam four feet high is being planned to divert the water into a nine-mile diversion canal.

The city of Seattle, Ore., has requested permission to use an additional 1,000 sec.-ft. of water for its Gorge plant, increasing the present output by 43,875 hp., and 700 sec.-ft. additional for its Diablo plant, increasing the output by 23,182 horsepower.

Following two years of preliminary work, workmen have begun to clear the dam site for the North River hydro-electric project in Pacific and Grays Harbor Counties, Wash., which will be developed by the Western Washington Light & Power Company.

The project calls for construction of a $3,500,000 plant and a transmission line from Aberdeen to Raymond. The dam, 120 ft. high and 400 ft. long at the crest, will create a reservoir covering 7,600 acres. Two 12,500-hp. turbine-generators will be installed, with provisions for a third of the same capacity when needed.

August 5, 1929

marked the two hundredth anniversary of the death of

THOMAS NEWCOMEN,

inventor of the first successful atmospheric steam engine

FITTING homage to the memory of this great engineer was paid at the recent joint meetings of the Newcomen Society and the Devonshire Association for the Advancement of Science, Literature and Art, held in Dartmouth, England, where Newcomen was born.

Electric Bond & Share Case Adjourned Until Sept. 16

After a conference in New York last week between attorneys of the Federal Trade Commission and the Electric Bond & Share Company, it was agreed that no further court action will be taken before September 16 concerning Federal Judge Knox's recent decision on the seizure of books and the taking of testimony in the commission's public utility investigation. Both sides have signed a stipulation to this effect. This will give the contesting parties a few weeks to lay out plans of action and to consider the legal significance of the court ruling. If action is not taken, the decree will stand in force as delivered. Protest by one side or the other is generally expected, but not certain. It might involve the taking of testimony before a master appointed by the same court to obtain another decision by Judge Knox or it might mean appeal to a higher court.

News of Canada

Uniformity of Qualifications for Engineers' Certificates Lacking in Provinces—Alberta Regulations Given in Full

By CAMPBELL BRADSHAW
Toronto, Ont.

THAT a first-class Ontario certificate permits operation of a steam plant of any capacity anywhere in Canada is an erroneous belief. It is true that following a conference in Winnipeg in 1918, attended by delegates from British Columbia, Alberta, Saskatchewan, Manitoba, Ontario, Quebec and Nova Scotia, interprovincial regulations for the construction of boilers and other pressure vessels were adopted by half a dozen of the provinces represented, but no similar "standardization" of the qualifications of engineers has ever been adopted; each province setting up its own standard and grade of certificate. As a result, an Alberta engineer seeking to operate a plant of, say, 800 hp. in Ontario, may have to write the examination for a first-class certificate in the latter province, although the 1927 stationary and hoisting engineers' act allows the board of examiners, consisting of J. M. Brown, chairman; W. J. Scott and S. G. Rose, to grant provisional certificates for a period of not more than one year.

The regulations, and, in some provinces, even the grade of certificates issued, are far from uniform. In Alberta, for instance, the certificates granted are: First class, second class, third class, traction engineers' final, special, firemen's final, and provisional.

A candidate for a fireman's final certificate must be not less than twenty years of age and have had at least six months' experience firing. The examination consists of questions relating to the operation, maintenance and care of a boiler, and heating plant equipment. Successful candidates are allowed to have charge of heating boilers, not exceeding 15 hp., carrying a pressure of not more than 100 lb.

Special certificates are issued for the operation only of a railroad locomotive, steam shovel, hoisting or portable boiler, of not more than 200 hp. The holder of a traction engineer's final certificate is allowed to operate a traction boiler only.

Candidates for third-class certificates in Alberta must furnish proof that they have served as firemen for a period of twelve months, operated a boiler and engine for a further period of twelve months, or worked in an engine or boiler repair shop for twelve months; or hold a certificate in steam engineering issued by a duly recognized school of technology, and have served as firemen for a period of six months. On receiving not less than 60 per cent of the total marks obtainable in the examination, the candidate is allowed to have charge of a steam plant not in excess of 200 hp. or may act as shift engineer in a plant with boilers up to 500 hp.

The examination consists principally

of questions relating to the following: Description of boilers, fittings, equipment and settings; elements of combustion, pumps, etc.; details of engine parts, valve gears and settings, governors and fly wheels; engine room auxiliaries, lubrication, foundations, etc.; description of ammonia compression systems of refrigeration; direct- and alternating-current dynamos and motors, switchboards, transformers, etc.

Candidates for second-class certificates must be at least 22 years of age, have served four years in charge of a boiler and engine of not less than 50 hp., or have served two years in an engine or boiler shop, and as engineer of a plant of not less than 75 hp. for two years; or hold a two-year diploma in power plant engineering from a recognized school of technology, and, in addition, have operated a steam plant of not less than 75 hp. for a period of not less than 36 months. All candidates for second-class certificates must have operated a plant for at least six months, as the holder of a third-class certificate.

In addition to the subjects given third-class men the examination for second-class certificates includes questions on boiler room piping, valves and auxiliaries; boiler calculations; feed water treatment; air compressors; pumping engines and pumps; indicator diagrams; condensors; air compressors; indicated horsepower calculations; refrigeration systems; safety appliances; a.-c. and d.-c. machinery; mensuration, arithmetic, material of construction; strength of simple structures, etc.

Successful candidates may operate steam plants of not more than 500 hp., or take charge of a shift in any plant of which a first-class engineer is in charge.

To obtain a first-class certificate an engineer must be at least 25 years old, furnish proof that he has been employed as a machinist or boilermaker, on the repairing or building of steam engines or boilers, for not less than 24 months, and has had charge of a steam plant, of not less than 300 hp. in boiler capacity, and of engines aggregating not less than 300 hp., for a period of at least twelve months; or has operated a steam plant of the aforesaid capacity as chief engineer for a total period of five years, including six months in Alberta; or hold the two-year diploma of a recognized school of technology, and, in addition, have operated a steam plant of the aforesaid capacity as chief engineer for a total period of four years, including six months in Alberta.

Candidates must receive 70 per cent of the total marks obtainable, and can, on obtaining a first-class certificate, take charge of a plant of any capacity.

In addition to the subjects given second- and third-class men, the questions given applicants for a first-class certificate relate principally to the following: Strength of boiler sheets, riveting, stays, etc., to comply with the Canadian interprovincial regulations; automatic stokers, boiler tests, etc.; modern power plant practice, valves and valve diagrams, indicators and power brakes; engine and turbine repairs and tests; installation, etc.; a.-c. and d.-c. generators and motors, transmission of electricity, etc.; installation and operation of refrigeration systems; mathematics, logarithms, etc.; thermodynamics, theory of heat engines, application to boiler and efficiency tests.

F. W. Hobson is chief inspector of steam boilers and G. W. Keddy, chief clerk, Steam Boilers Branch, Department of Public Works, Edmonton, Alta.

[Next week Mr. Bradshaw will discuss rules and regulations in Ontario.—The Editor.]

OBITUARY

CHARLES H. SCHRODER, for 27 years secretary of the Murray Iron Works Company of Burlington, Iowa, died July 29 at the age of 62. Mr. Schroder entered the employ of this company 47 years ago and developed into an expert and authority on steam boilers. He was capable in business and highly esteemed by his associates.

CHARLES W. KINCAID, II, aged 40 years, of Pittsburgh, Pa., a special engineer in the industrial motor engineering department of the Westinghouse Electric and Manufacturing Company, died Sunday, July 14, following a long illness. He was graduated in 1910 from the University of Pittsburgh with the degree of Electrical Engineer. He entered the employ of the Westinghouse Company in the same year, and in his nineteen years' service with that firm held successively positions as alternating current motor designer, section engineer on alternating current motors, and consulting specialist on industrial problems.

LOUIS E. BEAN, chairman of the Oregon Public Service Commission, died in Salem, Ore., July 6, following a heart attack. For nearly three years Mr. Bean had served as a member of the commission and during the last two years had been its chairman.

PERSONALS

A. H. PETERS, formerly mechanical engineer with Marston & Company, building managers, has taken a position as mechanical engineer at the Woolworth Building, in New York City.

WALTER H. DAMON, for many years superintendent of operation and later consulting engineer with the United Electric Light Company, Springfield, Mass., has recently retired from active service. Mr. Damon is a past president of the National Association of Power Engineers and a past worthy chief of the Universal Craftsmen Council of Engineers.

J. P. MORRISON, chief inspector for the Chicago department of the Hartford Steam Boiler Inspection & Insurance Company, has been made superintendent of inspections, in charge of this work throughout the country. C. W. Zimmer has been promoted to chief inspector to succeed Mr. Morrison at Chicago.

A. V. BENNETT, vice-president of the West Penn Electric Company, West Penn Power Company and subsidiary companies, has retired after fifteen years of service with the West Penn organization.

EDWIN W. KRAMER, hydro-electric engineer of the California District of the United States Forest Service, has been made district engineer. He succeeds Frank E. Bonner, who has been appointed secretary of the Federal Power Commission at Washington, D. C.

CHARLES E. EVELETH, vice-president of the General Electric Company, has been transferred from the manufacturing to the engineering department, where he will be associated with E. W. Allen in the management of that department's affairs.

HAROLD S. FALK, vice-president and works manager of the Falk Corporation, Milwaukee, Wis., has been appointed chairman of the committee on industrial education of the National Metal Trades Association. Mr. Falk is also a member of the committee on education and training for the industries of the A.S.M.E.

RALPH O. WALTHAM, for the past seven years assistant engineer in the gas and electric division of the engineering department of the California Railroad Commission, has resigned to become managing editor of *Electric Light and Power*, Chicago.

BUSINESS NOTES

STUEBING COWAN COMPANY, Cincinnati, Ohio, manufacturers of hand lift trucks, has been purchased by the Yale & Towne Manufacturing Company, Stamford, Conn. The absorption of the former company will enable the Yale & Towne company to add to its line of devices for the handling of materials.

CHICAGO PUMP COMPANY has announced a change in its representative at Portland, Ore. In the future the territory will be under the supervision of D. R. Monro, 201 Lumbermans Building, Portland, Ore.

LANGLEY MANUFACTURING COMPANY, LTD., of Winnipeg and Vancouver, B. C., has been purchased by the Amalgamated Electric Corporation, Ltd., of Toronto. S. Langley, president of the former organization, will hold an executive office in the new company.

ILLINOIS CENTRAL RAILROAD COMPANY has ordered five 600-hp. oil-electric locomotives from Ingersoll-Rand Company and the General Electric Company.

AMERICAN PULLEY COMPANY, Philadelphia, Pa., has taken over all products of the Sprucolite Corporation, of Bloomfield, N. J. This line of pulleys, to be known hereafter as American Sprucolite, are made from impregnated laminated spruce. They will complete the line of power-transmission equipment manufactured by the American Pulley Company.

STRONG-SCOTT MANUFACTURING COMPANY, Minneapolis, Minn., has announced the appointment of E. H. Bollenbacher as sales agent in the Southeast, handling fuel pulverizers and other grinding mills for all purposes.

SHEFFLER-GROSS COMPANY, INC., Philadelphia, Pa., sales engineers of power plant equipment, announces that Justin J. McCarthy has joined the company as a sales engineer.

PREST-O-LITE COMPANY, INC., New York City, has recently added two new acetylene gas plants to its organization. One is located at 540 East 17th St., Wichita, Kan., and the other at Jones St. and Pennsylvania Railroad, Youngstown, Ohio. These plants will supply local industries with dissolved acetylene for welding purposes.

Coming Conventions

American Institute of Electrical Engineers. Pacific Coast Regional Meeting, Santa Monica, Calif. Sept. 3-6. F. L. Hutchinson, secretary, 33 West 39th St., New York City.

American Welding Society. Fall meeting at Cleveland, Ohio, Sept. 9-13. Secretary, M. M. Kelly, 33 West 39th St., New York City.

National Association of Power Engineers, 47th annual convention, Chattanooga, Tenn., Sept. 9-13. Fred Raven, secretary, 417 South Dearborn St., Chicago, Ill.

National Association of Practical Refrigerating Engineers. Twentieth annual convention at the William Penn Hotel, Pittsburgh, Pa., Nov. 4-7. Secretary, E. H. Fox, 5707 W. Lake St., Chicago, Ill.

National Exposition of Power and Mechanical Engineering, Grand Central Palace, New York City, Dec. 2-7. Charles F. Roth, manager, Grand Central Palace, New York City.

Universal Craftsmen Council of Engineers. Annual meeting in Detroit, Mich., Aug. 6-10, at the Book-Cadillac Hotel. Grand Secretary, T. H. Jones, 33 Linden Ave., Cherrydale, Va.

World Engineering Conference, Tokyo, Japan, October, 1929. All correspondence should be addressed to the Secretary, World Engineering Conference, Nikon, Kogyo Club, Morunouchi, Tokyo.

TRADE CATALOGS

WATER LEVEL INDICATOR—A bulletin describing the new C-E water level indicator has been published by the Combustion Engineering Corporation, 200 Madison Ave., New York City. Description and illustrations of the indicator, which may be placed where it can be easily read no matter where the gage glass is located, are given in the folder.

AIR COMPRESSORS—The Pennsylvania Pump and Compressor Company, Easton, Pa., has given a detailed description of its single stage air compressor in a new bulletin, No. 147. Cross-section views of special features, description of methods of compressor regulation, and a table of sizes and ratings add to the value of the bulletin.

HYDRAULIC TURBINES—A 75-page booklet issued by the Allis-Chalmers Manufacturing Company, Milwaukee, Wis., gives a comprehensive picture of some of the recent installations of turbines and auxiliary equipment. Over 100 illustrations are included in the bulletin, which is listed as No. 1644.

TRANSMISSION — Stephens-Adamson Manufacturing Company, Aurora, Ill., has issued an attractive and useful bulletin descriptive of the new J. F. S. variable-reducer transmission, embodying the purposes of both a variable-speed transmission and a speed reducing unit. Two general types are made, one having a maximum reduction ratio of 8 to 1 and the other a reduction ratio of about 40 to 1. Each machine has a variation range of about 5 to 1. The speed changes are accomplished while the machine is in motion by the turning of a control wheel.

STEAM ENGINES—Catalog F, an attractive 40-page booklet published by the Troy Engine & Machine Company, Troy, Pa., presents much information concerning the various models of Troy self-oiling steam engines. Photographs and tables of specifications are a feature of the catalog.

MOTORS AND MOTOR STARTERS—"Power at the Touch of a Button," a bulletin recently released by the Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa., describes "linestarters" and "linestart" motors, which permit motor control at the push of a button. Applications of the equipment supplement the descriptions and illustrations. The type SK totally-enclosed, fan-cooled motors, also a product of the Westinghouse company, are described and pictured in folder No. 5188, also recently released.

VALVES—Schutte & Koerting Company, Philadelphia, Pa., has published a new edition of its bulletin 8-B, which describes the stop, check, non-return and triple-duty valves for steam pressures up to 1,500 lb. that this company now manufactures. The bulletin is illustrated and contains tables useful in selecting the proper valve.

PULLEYS—Bulletin No. 272, published by the T. B. Wood's Sons Company, Chambersburg, Pa., describes ball bearing pulleys, friction clutches and cut-off couplings manufactured by that company. A price list for ball-bearing pulleys of various sizes is included.

FUEL PRICES

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; mine run, except Pittsburgh gas slack:

Bituminous (Net Tons)	Market Quoting	Price per Ton
Navy Standard	New York	$2.00 @ $2.35
Kanawha	Columbus	1.25 @ 1.50
Smokeless	Cincinnati	1.75 @ 2.00
Smokeless	Chicago	1.75 @ 2.25
S. E. Kentucky	Chicago	1.35 @ 1.60
Steam	Pittsburgh	1.55 @ 1.65
Gas Slack	Pittsburgh	1.00 @ 1.10
Big Seam	Birmingham	1.50 @ 1.75
Anthracite		
(Gross Tons)		
Buckwheat	New York	$2.50@$2.75
Barley	New York	1.50

FUEL OIL

New York—Aug. 1, f.o.b. Bayonne, N. J., 28@34 deg., Baumé, industrial use, tank-car lots, 5.25c. per gal.; 36@40 deg., furnace, tank-car lots, 6c. per gal.

St. Louis—July 24, tank-car lots, f.o.b. St. Louis, 24@26 deg., $1.3959 per bbl. or 42 gal.; 26@28 deg., $1.4409 per bbl.; 28@30 deg., $1.4959 per bbl.; 30@32 deg., $1.5409 per bbl.; 32@36 deg., gas oil, 4.276c. per gal.; 38@40 deg., distillate, 5.248c.

Pittsburgh — July 30, f.o.b. local refinery, 30@34 deg., fuel oil, 5c. per gal.; 36@40 deg., 5.5c. per gal.

Philadelphia — July 25, 13@19 deg., $1.05@$1.10 per bbl. or 42 gal.; 22 deg. plus, $1.575@$1.625 per bbl.; 23@27 deg., $2.10@$2.15 per bbl.

Cincinnati — July 30, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 5c. per gal.; 26@30 deg., 5.25c. per gal.; 30@32 deg., 5.5c. per gal.

Chicago—July 23, tank-car lots, f.o.b. Oklahoma, freight to Chicago, 90c. per bbl. or 42 gal.; 22@26 deg., 65c. per bbl.; 26@30 deg., 85c. per bbl.; 30@32 deg., $1.00 per bbl.

Boston—July 29, tank-car lots, f.o.b. 12@14 deg. Baumé, 4.3c. per gal. 28@32 deg., 5.4c. per gal.

Dallas—July 20, f.o.b. local refinery, 26@30 deg., $1.30 per bbl. or 42 gallons.

New Plant Construction

COMPILED BY THE McGRAW-HILL BUSINESS NEWS DEPARTMENT, WHICH IS PREPARED TO FURNISH A MORE COMPLETE DAILY SERVICE TO THOSE WHO WISH IT

Ala., Mobile—City Comn., A. Bates, Mayor, plans election to vote $300,000 bonds power plant, etc.

Calif., Compton—Southern California Edison Co., Edison Bldg., Los Angeles, having plans prepared for construction substation. Estimated cost $200,000. Engineer Department for owner is engineer.

Calif., Los Angeles—Banks-Huntley Co., Investment Brokers, Stock Exchange Bldg., is receiving bids for a 13 story office building including steam heating system, elevators, etc., at Spring St. between 6th and 7th Sts. Estimated cost $1,000,000. John and Donald B. Parkinson, 808 Title Insurance Bldg., are architects.

Calif., Los Angeles—H. G. Ferguson, Corp., Los Angeles, having preliminary plans prepared for office, including steam heating and electric elevators, at 6th and Flower Sts. Estimated cost $1,000,000. Walker & Eisen, Western Pacific Bldg, are architects.

Conn., Bridgeport—United Illuminating Co., 1118 Broad St., awarded contract for the construction power house, East Main St. to Edward Bray Co., 362 River St. Estimated cost $350,000.

Conn., Waterbury—Connecticut Light & Power Co., 111 West Main St., awarded contract altering service building to United Engineers & Constructors, Inc., Broad and Arch Sts., Phila., Pa. Estimated cost $100,000.

Conn., New Britain—Hardware City Storage Co., Inc., F. W. Shultz, Pres., 551 Stanley St., plans the construction of a cold storage plant and warehouse. Estimated cost $150,000. Architect not selected.

Conn., Waterbury—Fulton Markets, Inc., C. Greenblatt, West Main St., plans construction 2 story, cold storage plant, West Main St. Estimated cost $40,000. Private plans.

Fla., Hollywood—City Manager, will receive bids until August 15, pumping station, etc. for waterworks. Estimated cost $28,000. G. C. White Co., 406 Main St., Durham, N. C. is engineer.

Ill., Chicago—Link Belt Co., 310 West Pershing Rd., awarded contract for masonry, etc., for a 30 x 48 ft. boiler room. Estimated cost $26,000.

Ill., Chicago Heights—Columbia Tool Steel Co., A. T. Clarage, pres., taking bids for the construction power plant. Sessions Engineering Co., 228 North La Salle St., Chicago, is engineer and will purchase compressors, pumps, engine and steam piping equipment.

Ky., Louisville—Louisville Gas & Electric Co., 311 West Chestnut St., will build 250 ft. steel stack and appurtenances, and install 2,500 hp. boiler, at steam electric generating station, 3rd St. and Ohio River, $500,000. Work will be done by company forces.

Mass., Hopkinton—Water Comrs., Town Hall, will receive bids until August 8, erecting pumping station. Hydraulic Development Co., 296 Boylston St., Boston, engr.

Mass., Lexington—W. E. Doran, East St., awarded contract for the construction of two greenhouses and boiler house to D. A. Stewart, 292 Lake St., Arlington.

Mass., North Reading—Department Public Health, Commonwealth of Massachusetts, Boston, will receive bids until August 14, admitting isolating building, including power house. Estimated cost $175,000. Stevens & Lee, 45 Newbury St., Boston, are architects.

Mass., Provincetown—Provincetown Art Association, W. H. Young, Pres., 10 Carver St., plans addition to boiler room. Estimated cost $25,000. Private plans.

Mass., West Springfield (mail Springfield)—Strathmore Paper Co., soon lets contract hydro electric plant. Estimated cost $40,000. L. R. Howe, c/o owner is engineer.

Mass., Worcester—M. J. Whittall Associates, have retained F. J. Sill, Westboro, to design and construct steam power plant. Estimated cost $400,000.

Miss., Cleveland—W. C. Trotter, secy. Building Committee, Jackson, will receive bids until August 8, boiler house, boiler plant, outside steam distributing system, etc. at Delta State Teachers College. C. H. Lindsley, Jackson, is engineer.

Mo., St. Louis—Proctor & Gamble Co., 169 East Grand Ave., awarded contract for the construction of a 60 x 90 ft. boiler plant at 139 East Grand Ave. to H. K. Ferguson Co., Hanna Bldg., Cleveland, O. Estimated cost $125,000.

Miss., Oxford—W. C. Trotter, secy. Building Committee, Jackson, will receive bids until Aug. 8, smoke stack, power plant equipment, etc. for University of Mississippi. F. P. Gates Co., Jackson, engr.

N. J., Jersey City—Pennsylvania R.R. Co., T. J. Skillman, ch. engr., Broad Street Station, Phila., Pa. plans the construction of cold storage and warehouse, Exchange Pl. and Hudson River. Estimated cost $1,000,000. G. F. Bial, 135 Summit Ave., Union City is architect.

N. Y., Brooklyn—City, c/o W. J. Hefferman, Municipal Bldg., Archt., plans the construction of a boiler room, etc. at 2nd Ave. and 3rd St. Estimated cost $40,000.

O., Ashtabula—Cleveland Electric Illuminating Co., W. H. Hartman, Purchasing Agent, awarded contract for the construction of foundation for power house to Hunkin-Conkey Constr. Co., Newman-Stern Bldg., Cleveland. Total estimated cost $11,000,000.

Pa., Pittsburgh — A. Garfield, Archt., National City Bldg., Cleveland, O., will receive bids August 7, from selected list of bidders for the construction of office building, University Pl., for National Union Fire Insurance, 139 University Pl. Estimated cost $600,000. J. P. Jones, Hunkin Conkey Bldg., Cleveland, O., is mechanical engineer.

Tex., Mercedes—Central Power & Light Co., San Benito, soon lets contract 150 tons daily capacity ice factory, here. Estimated cost $150,000. J. M. Marriott, San Antonio, is engineer.

Tex., San Angelo—West Texas Utility Co., awarded contract 17,500 h.p. steam turbo generator to Allis-Chalmers Mfg. Co., West Allis, Milwaukee, Wis., and two 1,000 h.p. boilers to Babcock & Wilcox Co., 85 Liberty St., New York.

Wash., Centralia—City awarded contract for the construction of diversion dam, and spillway gates, to divert water of Nisqually River, 6 mi. southeast of Yelm, in connection with municipal power project to E. T. Fisher, Centralia.

Wash., Tacoma—Board of Contracts & Awards, will receive bids until August 8, constructing power house, tank and penstock, etc. for Cushman Power Project in Olympic Mountains.

Equipment Wanted

Boiler—David City, Neb., R. D. Sweenie, City Clk., will receive bids until August 15, 250 hp. water tube boiler, piping, stokers, etc. Estimated cost $17,000.

Compressor or Blower Equipment — Stratford, Ont., W. H. Riehl, City Engineer, will receive bids until August 9, compressor or blower equipment, for sewage disposal plant. Estimated cost $40,000.

Fuel Oil Burning Equipment — Hines, Ill. U. S. Veterans' Bureau, Arlington Bldg., Wash., D. C. will receive bids about August 20, furnishing and installing complete fuel oil burning equipment, at U. S. Veterans' Hospital, here.

Generating Unit—Columbus, O., Bd. Purchase, H. C. Cain, Secy., City Hall, will receive bids until Aug. 15, one steam turbine generating unit with appurtenances, surface condenser, etc., for Municipal light plant.

Pump—M. L. Birnie, clerk, City of Chino, Calif., will receive bids until Sept. 3, installing 125 in. capacity pump equipped with 100 h.p. direct motor, in well.

Pumps—Vallajo, Calif., Pacific Gas & Electric Co., 445 Sutter St., San Francisco, plans installing motor driven pumps and equipment on 16 in. salt water line for supply Vallejo Gas plant. $25,000. Private plans.

Pumping Equipment—Minco, Okla.—City plans election August 5, new pumping equipment. Estimated cost $7,000. Long & Co., Colcord Bldg., Oklahoma City, are engineers.

Pumping Units—Board of State Engineers, 213 New Orleans Court Bldg., New Orleans, will receive bids until Aug. 26, 2 large electric driven pumping units, and auxiliary accessories, 8 metal sluice gate valves, etc., for proposed pumping plant and flood gate, at Alexandria.

Transformers—City Commission, Jacksonville, Fla., will receive bids until August 26, power and distributing transformers, both pole and subway type. G. M. Gordon, is purchasing agent.

Turbines and Generators—City of Centralia, Wash., will receive bids until Aug. 13, turbines and generators for municipal power plant, now under construction.

Industrial Projects

Calif., Los Angeles—BAG FACTORY—Bates Valve Paper Bag Co., 2001 East 57th St., awarded contract for the construction of factory, Miller and Medford Aves. Estimated cost $160,000. Austin Co. of California, 777 East Washington St., is architect.

Calif., Santa Ana—GLASS FACTORY—Pittsburgh Plate Glass Co., Frick Bldg., Pittsburgh, Pa., awarded contract for the construction plate glass factory, on 80 acre tract at Fairview and Bristol Sts. to Stone & Webster, Laughlin Bldg., Los Angeles. Estimated cost $4,000,000.

Conn., East Hartford (br. Hartford)—AIRPLANE FACTORY—Chance Vought Corp., Long Island City, N. Y., having plans prepared for construction airplane factory. Estimated cost $1,000,000. A. Kahn, 1004 Marquette Bldg., Detroit, Mich., is engineer.

Mass., Holyoke—PAPER FACTORY—Chemical Paper Co., R. Bosworth, awarded contract for the construction 2 story, paper plant to Casper Ranger Co., 20 Bond St. Estimated cost $175,000.

Minn., St. Paul—FACTORY—Minnesota Mining & Mfg. Co., Forest and Fauquier Sts., awarded contract to W. M. Murphy & Son, 1608 Pioneer Bldg. Estimated cost $150,000.

N. J., East Rutherford (mail Rutherford) — FACTORY — Flintkote Co., Maple St., East Rutherford, soon lets contract for the construction factory addition. Estimated cost $150,000. Private plans.

N. J., Newark—BAKERY—Dugan Bros., Inc., 161 Abington Ave., awarded contract construction bakery plant addition, 161 Abington Rd. to Federal Constr. Co., 649 Bway. Estimated cost $60,000.

N. Y., New York—BOILER ROOM—H and J. Guttag, Corp., J. Guttag, secy., 16 Exchange Pl., plans the construction of boiler room and storage, 42 Stone and 75 Pearl Sts. Estimated cost $85,000. H. Tanenbaum, 16 Exchange Pl., is engineer.

O., Cleveland — FACTORY and BOILER HOUSE—Ohio Overall Cleaning Co., W. N. White, vice-pres., 8008 Central Ave., having plans prepared factory and boiler house, 8008 Central Ave. Estimated cost $50,000. H. M. Morse, Finance Bldg., is engineer.

Pa., Ambridge—PLANT—H. H. Robertson Co., 14th St., awarded contract for construction warehouse and plant extension to Penn Bridge Co., College Hill. Estimated cost $60,000.

Pa., New Kensington—MACHINE SHOP, etc. —Aluminum Company of America, plans the construction of machine shop and altering plant into storage building and new machine shop; also constructing tube mill, at Arnold, Pa. Estimated cost $1,000,000. J. W. Schreiber, Smithfield Bldg., Pittsburgh, is engineer.

Pa., Phila.—FACTORY—American Cigar Co., 1111 5th Ave., New York, awarded contract factory at 68th and Greenway Sts. to Turner Constr. Co., 1700 Walnut St.

Pa., Pittsburgh—FACTORY—Fero Electric Air Pump Co., B. M. Fero, 509 Penwood Ave., Wilkinsburg, having preliminary plans prepared factory and garage, Pennsylvania Ave. Estimated cost $85,000.

R. I., Slatersville—MANGLE—Rendall Co., Slatersville, awarded contract for the construction of mangle building, with boiler room, to Temple & Crane, 80 Federal St., Boston, Mass. Estimated cost $60,000.

Tex., Texarkana — FERTILIZER PLANT — International Agricultural Corp., Wayne-Claughton Bldg., Atlanta, Ga., taking bids for construction fertilizer plant. Estimated cost $750,000.

W. Va., South Charleston—CHLORINE PLANT —Westwaco Chlorine Products, Inc., awarded contract for construction group of plant buildings, to H. K. Ferguson Co., Hanna Bldg., Cleveland, O. Estimated cost $1,000,000.

Wis., Milwaukee—CHOCOLATE FACTORY—Ambrosia Chocolate Co., 331 5th St., awarded general contract for construction factory 5th St. to Selzer-Ornst, 192 4th St.

Ont., Niagara Falls—ABRASIVE PLANT—Lionite Abrasive Ltd., Stanley St., awarded contract for the construction abrasive plant to R. O. Towell, 870 Valley Way. Estimated cost $500,000.

Ont., Toronto—PIPE PLANT—Canadian Conduit Pipe Co., Ltd. plans constructing new plant. Estimated cost $100,000.